UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT No. 29

MERCER COUNTY SOILS

By R. S. SMITH, E. E. DeTURK, F. C. BAUER, and L. H. SMITH

URBANA, ILLINOIS, JUNE, 1925

The Soil Survey of Illinois was organized under the general supervision of Professor Cyril G. Hopkins, with Professor Jeremiah G. Mosier directly in charge of soil classification and mapping. After working in association on this undertaking for eighteen years, Professor Hopkins died and Professor Mosier followed two years later. The work of these two men enters so intimately into the whole project of the Illinois Soil Survey that it is impossible to disassociate their names from the individual county reports. Therefore recognition is hereby accorded Professors Hopkins and Mosier for their contribution to the work resulting in this publication.

INTRODUCTORY NOTE

It is a matter of common observation that soils vary tremendously in their productive power, depending upon their physical condition, their chemical composition, and their biological activities. For any comprehensive plan of soil improvement looking toward the permanent maintenance of our agricultural lands, a definite knowledge of the various existing kinds or types of soil is a first essential. It is the purpose of a soil survey to classify the various kinds of soil of a given area in such a manner as to permit definite characterization for description and for mapping. With the information that such a survey affords, every farmer or landowner of the surveyed area has at hand the basis for a rational system of improvement of his land. At the same time the Experiment Station is furnished an inventory of the soils of the state, upon which intelligently to base plans for those fundamental investigations so necessary for solving the problems of practical soil improvement.

This county soil report is one of a series reporting the results of the soil survey which, when completed, will cover the state of Illinois. Each county report is intended to be as nearly complete in itself as it is practicable to make it, even at the expense of some repetition. There is presented in the form of an Appendix a general discussion of the important principles of soil fertility, in order to help the farmer and landowner to understand the significance of the data furnished by the soil survey and to make intelligent application of the same in the maintenance and improvement of the land. In many cases it will be of advantage to study the Appendix in advance of the soil report proper.

Data from experiment fields representing the more extensive types of soil, and furnishing valuable information regarding effective practices in soil management, are embodied in form of a Supplement. This Supplement should be referred to in connection with the descriptions of the respective soil types found in the body of the report.

While the authors must assume the responsibility for the presentation of this report, it should be understood that the material for the report represents the contribution of a considerable number of the present and former members of the Agronomy Department working in their respective lines of soil mapping, soil analysis, and experiment field investigation. In this connection special recognition is due the late Professor J. G. Mosier, under whose direction the soil survey of Mercer county was conducted, and to Mr. S. V. Holt, who was in direct charge of the field party in the construction of the map.

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SUPPLEMENT

MERCER COUNTY SOILS

By R. S. SMITH, E. E. DE TURK, F. C. BAUER, AND L. H. SMITH[1]

LOCATION AND CLIMATE OF MERCER COUNTY

Mercer county is located in the northwestern part of Illinois, bordering the Mississippi river. It is a medium-sized county, about 548 square miles in area, 150 square miles of which is in the Mississippi river terrace and bottom. It lies in the region which was covered by the Illinoisan ice sheet during the Glacial period. Nearly all the land of the county is tillable, altho about 125 square miles, or 23 percent of the total area, is subject to active erosion and must be farmed with care if serious damage from washing is to be avoided. Some areas are so broken that they should be left in permanent pasture, or returned to timber.

The climate of Mercer county has a fairly wide range of temperature between the extremes of winter and summer. The greatest range for any one year in the twenty-year period from 1902 to 1922 was 125 degrees in 1905, 1916, and 1918. The lowest temperature recorded during this period was $-30°$, the highest 104°. The average date of the last killing frost in spring is April 28; the earliest in fall, October 15. The length of the growing season is, therefore, about 169 days.

The average annual rainfall for the county during the period from 1902 to 1922 was 33.09 inches. The average rainfall by months for this period was as follows: January, 1.59 inches; February, 1.27; March, 2.13; April, 3.15; May, 4.50; June, 3.94; July, 3.54; August, 3.11; September, 4.50; October, 2.32; November, 1.93; December, 1.31.

AGRICULTURAL PRODUCTION

Mercer county is agricultural in its interests. It is particularly well suited to livestock farming because the nature of the topography is such that certain portions of many of the farms in the county are especially adapted to pasturing, while other portions are adapted to growing the general farm crops. This combination of pasture and cropping land favors livestock farming.

According to the Fourteenth Census of the United States, there were in 1919 in this county, 2,022 farms having an average of 160.6 acres each, 129.7 acres of which were improved. Ninety-four percent of the county was in farms. During the past ten years there had been a slight decrease in tenantry.

The principal crops grown are corn, oats, wheat, barley, rye, and forage crops. The Census reports the following acreage and yields of the most important crops for 1919. It should be borne in mind that these figures represent the yields of only a single season.

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[1] R. S. Smith, in charge of soil survey mapping; E. E. DeTurk, in charge of soil analysis; F. C. Bauer, in charge of experiment fields; L. H. Smith, in charge of publications.

Crops	*Acreage*	*Production*	*Yield per acre*
Corn	94,080	4,099,112 bu.	43.6 bu.
Oats	34,082	1,035,235 bu.	30.4 bu.
Wheat	12,364	273,868 bu.	22.1 bu.
Barley	1,986	39,358 bu.	19.8 bu.
Rye	3,827	39,795 bu.	10.4 bu.
Timothy	8,227	10,454 tons	1.27 tons
Timothy and clover mixed	15,910	22,263 tons	1.40 tons
Clover	8,555	10,722 tons	1.25 tons
Alfalfa	535	1,442 tons	2.70 tons
Silage crops	2,068	17,324 tons	8.37 tons
Corn for forage	1,566	3,399 tons	2.17 tons

The appearance of the farms indicates that agriculture is relatively prosperous in Mercer county. Livestock farming should be further developed in order profitably to increase the acreage in permanent pasture and thus insure better control over erosion on the steeper slopes. The acreage of sweet clover for pasture and alfalfa for hay should be increased. Much of the rougher land of the county might be used for these purposes to good advantage.

The following table shows the distribution of livestock and livestock products, together with dairy products.

Animals and Animal Products	*Number*	*Value*
Horses	14,739	$1,433,405
Mules	1,459	191,089
Beef cattle	30,501	2,090,127
Dairy cattle	7,980	536,316
Sheep	15,502	177,734
Swine	119,337	2,822,075
Poultry	212,588	210,339
Eggs and chickens	——	495,646
Dairy products	——	302,872
Wool	94,850 lbs.	49,802

Fruit and vegetable growing has been of small importance. Nearly every farm has a small truck garden and orchard. More fruit is grown in the region north of Mannon than in any other portion of the county. The character of the soil and the rough topography of the region makes it well adapted for fruit growing. In the sand terrace, near Keithsburg and New Boston, the melon industry has grown rapidly because of the character of the soil.

GEOLOGY OF SOILS

An important period in the geological history of Illinois from the standpoint of soil formation was the Glacial period, during and following which time the materials were deposited from which the soils of the state have in large part been formed.

At that time snow and ice accumulated in the region of Labrador and to the west of Hudson Bay in such large amounts that the mass pushed outward from these centers, chiefly southward. In moving across the country from the north, the ice gathered up all sorts and sizes of material including clay, silt, sand, gravel, boulders, and even large masses of rock. As the ice mass pushed along over its bed an immense amount of rock powder was produced by the grinding or file-like action of the rock material imbedded in the ice. The front of the ice continued to advance until the rate of melting back just balanced the rate of forward movement. During the time when the front of the ice was

stationary, the rock material which was brought forward accumulated in a broad, usually undulating ridge, known as a terminal moraine. When the ice front receded, owing to the melting back being more rapid than the forward movement, the material carried in the ice was deposited more or less regularly over the area previously covered. A deposit formed thru such a process is known as a ground moraine.

During the Glacial period at least six distinct ice advances occurred that were separated by long periods of time. They are described as follows, in the order of their occurrence:

(1) The Nebraskan, which did not touch Illinois; (2) the Kansan, which covered the western parts of Hancock and Adams counties; (3) the Illinoisan, which covered all of the state except the northwest county (Jo Daviess), the southern part of Calhoun county, and the seven southernmost counties; (4) the Iowan, which covered a part of northern Illinois, the exact area, however, being difficult to determine because of the effect of the subsequent glaciations; (5) the early Wisconsin, which covered the northeastern part of the state as far west as Peoria and as far south as Shelbyville; (6) the late Wisconsin, which extended to the west line of McHenry county and south of the town of Milford in Iroquois county.

Only one of these great ice sheets, the Illinoisan, covered the area that now constitutes Mercer county. Previous to the ice invasion, this region was rough and hilly. The ice sheet cut down the higher points and filled the preglacial valleys with drift. The depth of the drift now varies from about 50 feet in the southern and western parts of the county to about 150 feet in the northern and eastern parts. Following this period the entire upland was covered by a wind-blown deposit, known as loess, which constitutes the mineral portion of the present soil excepting on slopes where erosion has exposed the till. In the western part of the county bordering the Mississippi bottom, the loess reaches a depth of 40 feet.

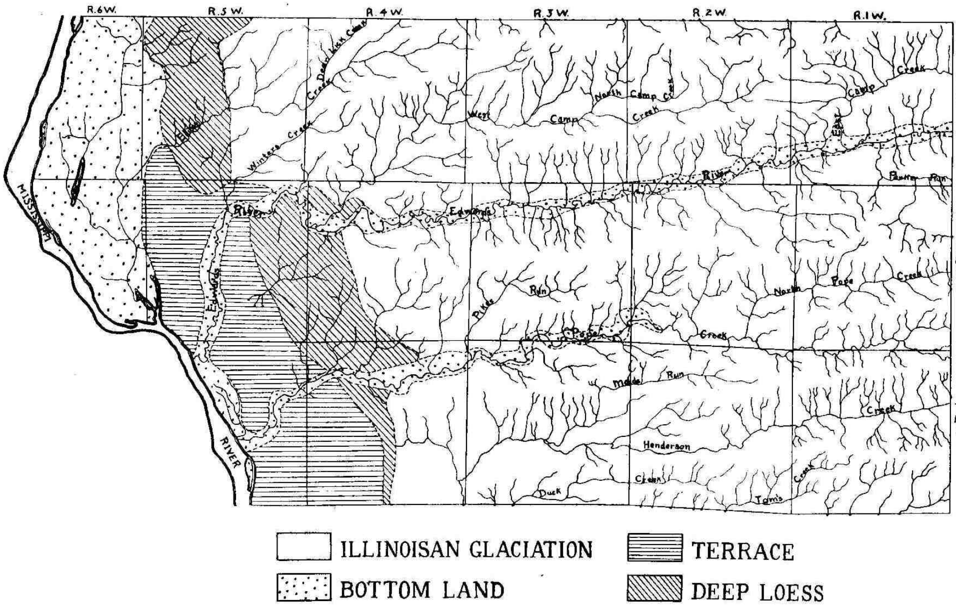
PHYSIOGRAPHY AND DRAINAGE

Mercer county presents striking variations in topography. The prairie areas vary from flat in the northern part of the county, between the towns of Hamlet and Preemption, to strongly undulating or rolling in the southern part of the county south of Pope creek. The topographic features of the county owe their origin to glacial action and to water and wind action. The undulating to rough nature of the topography adjacent to the Mississippi bottom is due in large part to the action of wind in drifting the sandy and fine sandy soil material.

The drainage of the county is thru two nearly parallel streams, Edwards river and Pope creek, which traverse the county in an east-west direction (see accompanying drainage map). The drainage of the county is good. The Mississippi bottoms were formerly swampy but since the construction of levees and dredge ditches, and the installation of pumping stations, practically the entire area is under cultivation.

The altitude of Mercer county varies from 535 feet in the Mississippi bottom at Keithsburg to about 812 feet in the eastern part of the county. The

altitudes of a few points in Mercer county are as follows: Aledo, 735 feet; Alexis, 690; Joy, 697; Keithsburg, 535; New Boston, 539; New Windsor, 806.



MAP SHOWING THE DRAINAGE BASINS OF MERCER COUNTY WITH UPLAND, TERRACE, BOTTOM-LAND, AND DEEP-LOESS AREAS

SOIL GROUPS

The soils of Mercer county are divided into four groups as follows:

(a) *Upland Prairie Soils,* usually rich in organic matter. These areas were originally covered with wild prairie grasses, the partially decayed roots of which have been the chief source of the organic matter.

(b) *Upland Timber Soils,* including those soils often found along stream courses, over which forests grew for a long period of time. These soils contain much less organic matter than the prairies because the large roots of dead trees and the surface accumulation of leaves, twigs, and fallen trees suffered almost complete decay or were burned by forest fires. The timbered soils are divided into two sub-groups, the undulating and the eroded.

(c) *Terrace Soils,* formed from deposits laid down by flooded streams during high water at the time of the melting of the glaciers. Finer deposits which were later made upon the coarser material now constitute the major part of the mineral portion of the soil. Large quantities of sand deposited on certain portions of the terrace have been reworked by the wind. These areas constitute the sand dune region of Mercer county.

(d) *Swamp and Bottom Lands,* which include flood plains along streams and some poorly drained muck and peat areas.

Table 1 gives a list of the soil types found in Mercer county, the area of each type in square miles and in acres, and also its percentage of the total area.

The accompanying map shows the location and boundary of each type of soil down to areas of only a few acres in extent.

For explanations concerning the classification of soils and interpretation of the map and tables, the reader is referred to the first part of the Appendix to this report.

TABLE 1.—SOIL TYPES OF MERCER COUNTY

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	(a) Upland Prairie Soils (500, 800)			
526	Brown Silt Loam	210.22	134 541	38.36
871	Brown Fine Sandy Loam	5.39	3 449	.98
520	Black Clay Loam	.40	256	.08
		216.01	138 246	39.42
	(b) Upland Timber Soils (500, 800)			
535	Yellow Silt Loam	109.99	70 394	20.07
534	Yellow-Gray Silt Loam	45.07	28 845	8.22
875	Yellow Fine Sandy Loam	16.18	10 355	2.95
874	Yellow-Gray Fine Sandy Loam	13.33	8 531	2.43
		184.57	118 125	33.67
	(c) Terrace Soils (1500)			
1526	Brown Silt Loam	16.63	10 643	3.04
1581	Dune Sand	13.19	8 442	2.41
1560	Brown Sandy Loam	9.43	6 035	1.72
1571	Brown Fine Sandy Loam	7.96	5 094	1.45
1528	Brown-Gray Silt Loam On Tight Clay	3.16	2 022	.58
1534	Yellow-Gray Silt Loam	3.01	1 926	.55
1564	Yellow-Gray Sandy Loam	2.32	1 485	.42
1520	Black Clay Loam	.32	205	.06
		56.02	35 853	10.23
	(d) Swamp and Bottom-Land Soils (1400)[1]			
1326 } 1426 }	Deep Brown Silt Loam	51.61	33 030	9.42
1415	Drab Clay	17.35	11 104	3.17
1354 } 1454 }	Mixed Loam	10.04	6 426	1.83
1421	Drab Clay Loam	5.12	3 277	.94
1460	Brown Sandy Loam	4.19	2 682	.76
1450	Black Mixed Loam	.70	448	.13
1320	Black Clay Loam	.36	230	.07
1463	Mixed Sandy Loam	.27	173	.05
1401	Deep Peat	.10	64	.02
1413	Muck On Clay	.08	51	.01
1480	River Sand	.08	51	.01
		89.90	57 536	16.41
	Water	1.49	954	.27
	Total	547.99	350 713	100.00

[1]See note on page 20 concerning subdivision of this group.

INVOICE OF THE ELEMENTS OF PLANT FOOD IN MERCER COUNTY SOILS

In order to obtain a knowledge of its chemical composition, each soil type is sampled in the manner described below and subjected to chemical analysis for its important plant-food elements. For this purpose samples are taken usually in sets of three to represent different strata in the top 40 inches of soil; namely, an upper stratum (0 to 6⅔ inches), a middle stratum (6⅔ to 20 inches), and a lower stratum (20 to 40 inches).

This, of course, is a purely arbitrary division of the soil section, very useful in arriving at a knowledge of the quantity and distribution of the elements of plant food in the soil, but it should be borne in mind that these strata seldom coincide with the natural strata as they actually exist in the soil and which are referred to in describing the soil types as surface, subsurface, and subsoil. By this system of sampling we have represented separately three zones for plant feeding. The upper, or surface layer, includes at least as much soil as is ordinarily turned with the plow, and this is the part with which the farm manure, limestone, phosphate, or other fertilizing material is incorporated.

The chemical analysis of a soil, obtained by the methods here employed, gives the invoice of the total stock of the several plant-food materials actually present in the soil strata sampled and analyzed. It should be understood, however, that the rate of liberation from their insoluble forms, a matter of at least equal importance, is governed by many factors.

For convenience in making application of the chemical analyses, the results as presented here have been translated from the percentage basis and are given in the accompanying tables in terms of pounds per acre. In this, the assumption is made that for ordinary types a stratum of dry soil of the area of an acre and 6⅔ inches thick weighs 2,000,000 pounds, exceptions being made of certain soils very high in organic matter, such as the peats and the mucks. It is understood, of course, that this value is only an approximation, but it is believed that with this understanding, it will suffice for the purpose intended. It is, of course, a simple matter to convert these figures back to the percentage basis in case one desires to consider the information in that form.

THE UPPER SAMPLING STRATUM

In Table 2 are reported the amount of organic carbon (which serves as a measure of the total organic matter), and the total quantities of nitrogen, phosphorus, sulfur, potassium, magnesium, and calcium in 2 million pounds of the surface soil of each type in Mercer county.

Because of the extreme variations frequently found within a given soil type with respect to the presence of limestone and acidity in different strata, no attempt is made to include in the tabulated results figures purporting to represent their averages in the respective types. In examining each soil type, in the field, however, numerous qualitative tests are made which furnish general information regarding the soil reaction, and in the following discussions of the individual soil types, recommendations based upon these tests are given concerning the lime requirement of the respective types. Such recommenda-

tions cannot be made specific in all cases because local variations exist, and because the lime requirement may change from time to time, especially under cropping and soil treatment. Therefore, it is often desirable to determine the lime requirement for a given field, and in this connection the reader is referred to the section in the Appendix dealing with the application of limestone (page 31).

In connection with Table 2, attention is called to the variation among the various soil types with respect to their content of the different plant-food elements.

It will be seen from the analyses that variations in the organic carbon content of the different soils are accompanied by a similar variation in the nitrogen content. The organic-carbon content is usually from 10 to 12 times that of the total nitrogen. This close relationship is explained by the well-established facts that all organic matter of the soil contains nitrogen, and that most of the soil nitrogen, usually 98 percent or more, is present in a state of organic combination. This close relationship is also maintained in the middle and lower sampling strata.

The organic matter, with its nitrogen, varies widely in the various soils of the county. The largest amounts are found in the swamp and bottom-land soils, especially those which are peaty. Deep Peat contains 198,850 pounds per acre of organic carbon, the largest amount found in any soil type in the county. Its corresponding nitrogen content is 15,990 pounds. The upland prairie soils are much higher in these constituents than are the timber soils, the average for the upland prairie soils being 69,890 pounds per acre of organic carbon and 4,650 pounds of nitrogen, as compared to only 28,420 and 2,460 pounds of the two elements, respectively, in the timber group. The relative deficiency of the timber soils in these important constituents serves to emphasize the necessity of giving particular attention to the return of organic materials to soils of this group when planning cropping systems.

Other elements are not so closely associated with each other as are organic matter and nitrogen. However, there is some degree of correlation between sulfur and organic carbon. This is because a considerable, tho varying, proportion of the sulfur in the soil exists in the organic form, i.e., as a constituent of the organic matter.

The potassium content is always low in peaty and muck soils, the minimum for Mercer county being 10,030 pounds per acre in Deep Peat. With the exception of peaty soils the potassium content averages about 30,000 pounds. The maximum amount, as shown in the analyses, is 36,580 pounds per acre in Drab Clay Loam, Bottom, but several other types have approximately the same amount.

The phosphorus content ranges from a minimum of 550 pounds per acre in Dune Sand, Terrace, to 2,260 pounds per acre in Black Clay Loam, Terrace.

Dune Sand contains the smallest amounts of calcium, magnesium, and phosphorus. The calcium content in this type is 6,670 pounds per acre, and that of magnesium 3,200 pounds. The maximum calcium content, 22,960 pounds, is found in Black Clay Loam, Terrace, as is also the maximum for magnesium, 14,900 pounds.

THE MIDDLE AND LOWER SAMPLING STRATA

The amounts of plant-food elements in the middle and lower sampling strata, are recorded in Tables 3 and 4.

In comparing these strata with the upper one, it will be noted that in the majority of the soil types the organic matter and nitrogen contents diminish rather rapidly with increasing depth, while the percentages of the other ele-

TABLE 2.—PLANT-FOOD ELEMENTS IN THE SOILS OF MERCER COUNTY, ILLINOIS
UPPER SAMPLING STRATUM: ABOUT 0 TO 6⅔ INCHES
Average pounds per acre in 2 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (500, 800)							
526	Brown Silt Loam	66 560	4 830	1 140	990	32 660	7 520	11 800
871	Brown Fine Sandy Loam	43 140	3 420	1 120	720	33 080	5 440	11 460
520	Black Clay Loam	99 960	5 700	1 480	1 600	29 920	10 060	17 880
	Upland Timber Soils (500, 800)							
534	Yellow-Gray Silt Loam	32 030	2 630	840	690	35 400	6 470	8 870
535	Yellow Silt Loam	24 570	2 030	690	680	33 010	7 110	7 660
874	Yellow-Gray Fine Sandy Loam	33 360	2 960	1 040	590	33 450	4 490	12 370
875	Yellow Fine Sandy Loam	23 710	2 230	840	340	35 200	7 640	12 300
	Terrace Soils (1500)							
1526	Brown Silt Loam	47 470	3 100	1 080	900	31 350	6 380	10 430
1571	Brown Fine Sandy Loam	45 820	3 600	1 200	760	30 360	6 200	10 380
1560	Brown Sandy Loam	30 090	2 130	1 100	550	27 980	4 180	8 060
1581	Dune Sand	12 760	1 020	550	520	24 560	3 200	6 670
1528	Brown-Gray Silt Loam On Tight Clay	53 730	4 840	1 610	1 010	34 490	6 590	7 210
1534	Yellow-Gray Silt Loam	26 080	1 960	860	580	35 580	5 800	10 080
1564	Yellow-Gray Sandy Loam	18 820	1 620	720	520	27 360	4 380	8 800
1520	Black Clay Loam	195 060	17 680	2 260	2 400	26 500	14 900	22 960
	Swamp and Bottom-Land Soils (1300 and 1400)							
1326, 1426	Deep Brown Silt Loam	62 120	5 120	1 795	1 080	33 120	10 290	14 390
1354, 1454	Mixed Loam[1]	......	......	......	......	......	......	......
1320	Black Clay Loam	87 120	7 220	2 040	1 180	33 100	11 640	22 540
1415	Drab Clay	55 210	4 890	1 660	1 000	32 460	11 970	17 120
1421	Drab Clay Loam	58 180	4 500	2 020	960	36 580	12 500	15 900
1460	Brown Sandy Loam	46 620	4 400	1 320	880	21 920	5 580	7 900
1450	Black Mixed Loam[1]	......	......	......	......	......	......	......
1463	Mixed Sandy Loam[1]	......	......	......	......	......	......	......
1401	Deep Peat[2]	198 850	15 990	1 210	2 600	10 030	6 020	17 920
1413	Muck On Clay[3]	177 300	14 500	1 170	2 820	19 350	9 450	19 690
1480	River Sand[4]	......	......	......	......	......	......	......

LIMESTONE AND SOIL ACIDITY.—In connection with these tabulated data, it should be explained that the figures for limestone content and soil acidity are omitted, not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in the form of general numerical averages reliable information concerning the limestone requirement for a given soil type. A general statement, however, will be found concerning the lime-requirement of the respective soil types in connection with the discussions which follow.

[1]On account of the heterogenous character of the mixed loams, chemical analyses are not included for these types.
[2]Amounts reported for Deep Peat are for 1 million pounds of soil.
[3]Amounts reported for Muck on Clay are for 1½ million pounds of soil.
[4]Not sampled.

ments for the most part remain about the same and in some cases increase slightly in the lower strata. In making these comparisons, it is necessary to bear in mind that the data as given for the middle and lower sampling strata are on the basis of 4 million and 6 million pounds of soil, and should therefore be divided by 2 and 3, respectively, thus converting them to a uniform basis of 2 million pounds before comparing them with each other or with the data for the upper stratum.

It is frequently of interest to know the total supply of a plant-food element accessible to the growing crops. While it is impracticable to obtain this information exactly, especially for the deeper-rooted crops, it seems probable that practically the entire feeding range of the roots of most of our common

TABLE 3.—PLANT-FOOD ELEMENTS IN THE SOILS OF MERCER COUNTY, ILLINOIS
MIDDLE SAMPLING STRATUM: ABOUT 6⅔ TO 20 INCHES
Average pounds per acre in 4 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (500, 800)							
526	Brown Silt Loam	94 620	7 020	1 930	1 660	65 560	18 820	23 110
871	Brown Fine Sandy Loam	53 920	4 600	1 960	1 120	68 080	14 680	22 080
520	Black Clay Loam	142 080	7 920	2 520	2 320	60 920	24 560	36 800
	Upland Timber Soils (500, 800)							
534	Yellow-Gray Silt Loam	27 110	2 630	1 550	890	71 470	18 430	16 800
535	Yellow Silt Loam	22 550	1 890	1 370	960	61 950	18 840	14 600
874	Yellow-Gray Fine Sandy Loam	26 620	2 920	1 640	500	69 500	11 780	23 340
875	Yellow Fine Sandy Loam	21 680	2 280	2 060	580	69 160	21 060	26 000
	Terrace Soils (1500)							
1526	Brown Silt Loam	69 140	4 500	1 960	1 740	63 680	11 360	20 100
1571	Brown Fine Sandy Loam	64 320	5 320	1 920	1 560	63 000	12 680	20 600
1560	Brown Sandy Loam	50 100	3 900	2 060	1 320	58 440	8 700	16 500
1581	Dune Sand	17 980	1 880	1 120	840	50 060	6 340	13 200
1528	Brown-Gray Silt Loam On Tight Clay	39 840	3 500	2 420	1 400	74 840	14 960	11 920
1534	Yellow-Gray Silt Loam	23 000	1 920	1 720	1 240	72 480	18 640	18 560
1564	Yellow-Gray Sandy Loam	18 480	2 240	1 160	680	55 840	7 800	15 600
1520	Black Clay Loam	151 320	12 800	2 720	2 200	61 640	29 240	37 720
	Swamp and Bottom-Land Soils (1300, 1400)							
1326, 1426	Deep Brown Silt Loam	91 180	7 440	2 660	2 050	64 120	22 360	27 980
1354, 1454	Mixed Loam[1]	......	......	......	......	......	......	......
1320	Black Clay Loam	112 720	10 400	3 960	1 440	68 960	25 680	41 680
1415	Drab Clay	66 940	6 060	2 440	1 440	61 700	25 320	34 540
1421	Drab Clay Loam	73 720	6 160	2 800	1 040	63 360	24 360	30 960
1460	Brown Sandy Loam	35 000	3 520	2 000	960	40 840	8 760	12 640
1450	Black Mixed Loam[1]	......	......	......	......	......	......	......
1463	Mixed Sandy Loam[1]	......	......	......	......	......	......	......
1401	Deep Peat[2]	483 560	36 360	2 060	5 880	15 240	10 040	39 940
1413	Muck On Clay[3]	255 960	19 830	1 800	3 570	35 940	15 540	36 300
1480	River Sand[4]	......	......	......	......	......	......	......

LIMESTONE AND SOIL ACIDITY—See note in Table 2.

[1]On account of the heterogenous character of the mixed loams, chemical analyses are not included for these types.
[2]Amounts reported for Deep Peat are for 2 million pounds of soil.
[3]Amounts reported for Muck on Clay are for 3 million pounds of soil.
[4]Not sampled.

field crops is included in the upper 40 inches of soil. By adding together, for a given soil type, the corresponding figures in Tables 2, 3, and 4, the total amounts of the respective plant-food elements to a depth of 40 inches may be ascertained.

Wide variation in composition is found in the sub-layers as well as in the top layer of the various soil types. The tables reveal further that there is not only this wide diversity among the different soils with respect to a given plant-food element, but that there is also a great variation with respect to the relative abundance of the various elements within a given soil type, as measured by crop requirements. For example, in the most extensive soil type in Mercer

TABLE 4.—PLANT-FOOD ELEMENTS IN THE SOILS OF MERCER COUNTY, ILLINOIS
LOWER SAMPLING STRATUM: ABOUT 20 TO 40 INCHES
Average pounds per acre in 6 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (500, 800)							
526	Brown Silt Loam	49 800	4 060	2 480	1 480	99 640	38 630	36 200
871	Brown Fine Sandy Loam	33 840	3 300	3 180	1 020	101 040	25 920	40 080
520	Black Clay Loam	67 800	3 900	3 600	1 860	85 220	42 600	48 720
	Upland Timber Soils (500, 800)							
534	Yellow-Gray Silt Loam	19 280	2 270	3 110	1 230	103 740	40 430	30 090
535	Yellow Silt Loam	19 480	1 560	1 940	1 040	89 380	29 000	22 380
874	Yellow-Gray Fine Sandy Loam	22 020	3 060	2 760	690	104 010	25 380	37 290
875	Yellow Fine Sandy Loam	24 960	2 880	3 180	810	100 260	33 840	64 200
	Terrace Soils (1500)							
1526	Brown Silt Loam	44 190	3 420	2 790	1 500	101 070	24 150	33 480
1571	Brown Fine Sandy Loam	47 040	4 200	2 460	1 380	100 140	22 620	35 400
1560	Brown Sandy Loam	36 930	3 270	3 150	1 230	86 400	15 840	25 470
1581	Dune Sand	18 810	1 950	1 500	1 110	76 920	10 920	20 580
1528	Brown-Gray Silt Loam On Tight Clay	34 020	3 930	3 630	1 350	101 580	43 410	28 620
1524	Yellow-Gray Silt Loam	24 420	1 160	3 360	1 560	105 660	37 260	30 960
1564	Yellow-Gray Sandy Loam	16 980	2 220	2 340	1 080	84 420	14 460	24 960
1520	Black Clay Loam	74 700	5 940	6 060	1 320	105 660	49 560	45 540
	Swamp and Bottom-Land Soils (1300, 1400)							
1326, 1426	Deep Brown Silt Loam	67 450	5 790	2 810	2 130	96 900	31 270	37 350
1354, 1454	Mixed Loam[1]	......	......	......	......	......	......	......
1320	Black Clay Loam	84 600	7 260	4 980	1 860	103 260	41 640	53 100
1415	Drab Clay	62 250	5 250	6 900	1 320	90 660	37 350	54 120
1421	Drab Clay Loam	57 480	6 060	2 400	840	92 100	32 760	44 880
1460	Brown Sandy Loam	19 440	2 640	1 920	1 140	59 700	10 860	15 360
1450	Black Mixed Loam[1]	......	......	......	......	......	......	......
1463	Mixed Sandy Loam[1]	......	......	......	......	......	......	......
1401	Deep Peat[2]	818 580	55 170	2 280	10 440	19 770	16 230	65 160
1413	Muck On Clay	230 580	16 740	1 980	3 060	85 560	31 200	63 060
1480	River Sand[3]	......	......	......	......	......	......	......

LIMESTONE AND SOIL ACIDITY—See note in Table 2.

[1]On account of the heterogenous character of the mixed loams, chemical analyses are not included for these types.

[2]Amounts reported for Deep Peat are for 3 million pounds of soil.

[3]Not sampled.

county, Brown Silt Loam, Upland, we find that the total quantity of nitrogen in an acre to a depth of 40 inches amounts to 15,910 pounds. This is about the amount of nitrogen contained in 15,900 bushels of corn. The amount of phosphorus, 5,550 pounds, contained in the same soil is equivalent to that contained in 32,600 bushels of corn; while in the same quantity of this soil, there is present 197,860 pounds of potassium, the equivalent of that contained in one million bushels of corn. In marked contrast to this soil, with respect to nitrogen is Yellow Silt Loam, the next most extensive type in the county, which contains in the 40-inch stratum approximately 5,480 pounds per acre of nitrogen, an amount equal to that in 5,480 bushels of corn. The phosphorus content is 4,000 pounds, or the equivalent of 23,500 bushels of corn, while the total amount of potassium is 184,340 pounds, equivalent to 970,000 bushels of corn. A significant variation in phosphorus content is found in Drab Clay, Bottom, which contains 11,000 pounds of this element, or the equivalent of 65,000 bushels of corn. The nitrogen and potassium in this type to a depth of 40 inches are essentially the same as in Brown Silt Loam.

These statements are not intended to imply that it is possible to predict how long it might be before a certain soil would become exhausted under a given system of cropping. Neither do the figures necessarily indicate the immediate procedure to be followed in the improvement of a soil, for other factors enter into consideration aside from merely the amount of plant-food elements present in the soil. Much depends upon the nature of the crops to be grown as to their utilization of plant-food materials, and much depends upon the condition of the plant-food substances themselves as to their availability. Finally, in planning the detailed procedure for the improvement of a soil, there enter for consideration all the economic factors involved in any fertilizer treatment. Such figures do, however, furnish an inventory of the total stocks of the plant-food elements that can possibly be drawn upon, and in this way these chemical data contribute fundamental information for the intelligent planning, in a broad way, of systems of soil management that will conserve and improve the fertility of the land.

DESCRIPTION OF INDIVIDUAL SOIL TYPES

(a) UPLAND PRAIRIE SOILS

The upland prairie soils of Mercer county occupy 216.01 square miles, or 39.42 percent of the area of the county. They occur in irregular-shaped areas traversing the county from east to west between the areas of timber soil which occur adjacent to the streams. The dark color of the prairie soils is due to the accumulation of organic matter which is derived, very largely, from the fibrous roots of the prairie grasses. The network of grass roots was protected from rapid and complete decay by the covering of fine, moist soil material and by the mat of vegetative material formed by old grass and leaves, which was very effective in excluding oxygen from the air. On the native prairies the stems and leaves were usually burned in part by prairie fires or disappeared in part by decay. Thus they added very little organic matter to the soil, but with a constant renewal of this vegetable debris, the decay of the roots was retarded considerably.

Brown Silt Loam (526)

The Brown Silt Loam of the upland covers an area of 210.22 square miles, or 38.36 percent of the area of the county. In topography, it varies from flat to undulating, becoming somewhat rolling at the sources of small streams. Towards the south part of the county, below Edwards river, Brown Silt Loam is strongly undulating. Considerable erosion has taken place in the more undulating areas. The dark-colored surface soil has been removed by erosion to such an extent from many of the slopes that it was necessary to map them as Yellow Silt Loam, which is the type name used for eroded timber soil. The fact should also be noted that many of these areas exist which are too small to be shown on the map. In the northern part of the county, Brown Silt Loam is heavier and verges on a silty clay loam.

The surface, which is usually from 6 to 8 inches in depth, varies from a brown silt loam with a grayish cast in the area south of Edwards river to a chocolate brown silt loam in the northern part of the county. This latter area has a deeper surface soil, frequently 10 to 12 inches deep, and it is a little finer in texture. West of Aledo, in Millersburg township (Township 14 North, Range 4 West), an area of Brown Silt Loam occurs that has a gray cast in the surface. The subsurface extends to a depth of 18 or 20 inches and varies from a brown silt loam with a slightly gray cast to a light brown or a yellowish brown silt loam, with some splotches of red iron concretions.

The subsoil, which is usually found at a depth of 18 to 20 inches, is a fairly compact, drabbish gray to grayish yellow silt loam to silty clay loam in its upper portion and a drabbish yellow or grayish yellow, fairly friable silt loam, containing many dark red iron concretions, in its lower portion. The depth to glacial till varies but, excepting on eroded slopes, does not occur at less than 4 or 5 feet from the surface. No carbonates are found to a depth of 40 inches.

Management.—Brown Silt Loam is a productive soil if given reasonably good care. Much of the area occupied by this type in Mercer county is naturally well drained, but when this is not the case, as on the flat areas, the first step in economical management is to provide good underdrainage. According to the tests made, the type is either not acid or only slightly acid, excepting in the eastern row of townships and in Preemption township (Township 15 North, Range 2 West). It is of course to be expected that exceptions to this general statement occur, since the reaction of a soil is exceedingly variable. For this reason, it is suggested that before limestone is applied, or before attempting to grow such crops as alfalfa or sweet clover without applying limestone, the county farm adviser or the Agricultural Experiment Station be consulted as to the need for it and the amount needed.

If this land is to be kept in a productive condition, or restored to a productive condition after its producing power has been lowered by poor farming, it is necessary to provide for frequent additions of fresh organic matter. All farm manure should be conserved and returned to the land, preferably for corn. Deep-rooting legumes, such as sweet clover or alfalfa, should occupy a prominent place in the rotation both because of their value as crops and because of their beneficial effects on the soil.

The information available regarding the use of phosphate fertilizers on this soil type is not entirely satisfactory because of conflicting results obtained on different experiment fields. On the Aledo experiment field, in the major system of plots, rock phosphate has been used at a financial loss, whether applied with manure or with residues along with limestone. However, in the minor system of plots on this same field, rock phosphate has returned a very good profit in increased crop yields.

At Galesburg and also at Kewanee rock phosphate, where applied with stable manure, failed to return its cost, but where applied with residues it produced very pronounced crop increases at Galesburg and yielded profitable returns at Kewanee.

The reader is referred to page 43 of the Supplement to this Report, where results from the Brown Silt Loam experiment fields are presented. It is suggested that this matter of phosphorus fertilization be given earnest consideration because of the fact that Brown Silt Loam in Mercer county is not high in phosphorus, and because it is much easier to prevent the depletion of this element of plant food than to restore it after depletion has resulted in declining yields.

Brown Fine Sandy Loam (871)

Brown Fine Sandy Loam occupies 5.39 square miles, or .98 percent of the area of the county. Practically all of this type is found in the vicinity of the towns of Joy and Seaton. The area south and west of Seaton is of a more rolling topography than that near Joy.

The surface, which is about 8 inches in depth, varies from a brown to a chocolate brown, fine sandy loam. The subsurface, extending to a depth of about 18 or 20 inches, varies from a light brown to a brownish yellow, fine sandy silt loam. The subsoil varies from a slightly mottled, yellow, fine sandy silt loam in the upper part to a friable, slightly mottled, light yellow silt loam in its lower part, containing some bright red streaks which are due to the presence of iron. Carbonates occur at a depth of about 40 inches. The area of Brown Fine Sandy Loam west of Seaton does not have a distinctly developed subsurface and subsoil. The subsoil is a friable, yellowish brown, fine sandy loam. No carbonates were found to a depth of 40 inches.

Management.—Tests for reaction showed this type to vary from slight to medium acidity, indicating that about 2 tons of limestone per acre should be used if alfalfa or sweet clover is to be grown. Red clover will grow fairly successfully excepting on the most acid areas of the type. Particular attention should be given to making regular additions of fresh organic matter, preferably legume residues, catch crops, and cover crops in order to maintain and increase the nitrogen supply in the soil.

The Experiment Station has no experimental data upon which to base recommendations for the fertilization of this soil type. Its deep, friable nature favors root penetration, thus allowing the roots to come in contact with the mineral elements of plant food contained in the soil at depths which, in some soils, are not reached by roots. This consideration makes it appear doubtful

whether any fertilizing material, other than manure, can be used at a profit, but it is suggested that, after adequate nitrogen and organic matter have been provided for by the growth of clovers, preferably sweet clover, a trial be made of one or more of the phosphates for wheat. The reader is referred to page 33 of the Appendix for a discussion of the various phosphate carriers and their method of use.

Black Clay Loam (520)

Black Clay Loam, because of its small area, is of minor importance in Mercer county. It occupies only 256 acres, or .08 percent of the area of the county. It is found chiefly in the southeast part of the county, near the town of North Henderson. The individual areas are small in size and some difficulty is found in mapping them because they vary from Black Clay Loam to Brown Silty Clay Loam. All of the areas are well drained.

The surface, which is about 8 inches deep, varies from a black, silty clay loam to a black clay loam. The subsurface extending to a depth of 18 inches is a very plastic black clay loam, verging on black clay in some borings. The subsoil varies from fairly compact, drab clay loam with some streaks of yellow silt in the upper part to a somewhat friable, drabbish gray, silty clay loam in the lower part, splotched with yellow silt and reddish yellow iron concretions below 30 inches. Carbonates were not found to occur in the 40-inch section, but the type is rarely acid.

Management.—This type is rarely in need of lime and is well supplied with the elements of plant food. The important consideration in its management is the maintenance of an adequate supply of freshly decaying organic matter, in order to counteract its tendency to become hard and difficult to work. For an account of field experiments on this soil type, see page 59 of the Supplement.

(b) UPLAND TIMBER SOILS

The upland timber soils are found widely distributed thruout the county, usually bordering the streams. These soils are characterized by a relatively low organic-matter content and a light color, which varies from a yellow to a yellowish brown or yellowish gray. The lack of organic matter has been caused by the long-continued growth of forest trees. As the forests invaded the prairies, the shading of the trees prevented the growth of prairie grasses, the roots of which are mainly responsible for the large amount of organic matter in the prairie soils. The trees themselves added very little organic matter to the soils, for the leaves and other debris either decayed very completely or were burned by forest fires.

Yellow-Gray Silt Loam (534)

Yellow-Gray Silt Loam occurs as an outer, light-colored soil belt bordering the streams. The topography of this type is undulating to slightly rolling. The natural drainage is good and with reasonable care to stop small gullies, and with good farming methods, but little difficulty should be encountered with washing. The type covers 45 square miles, or 8.22 percent of the area of the county.

The surface, which is about 6 or 7 inches deep, varies from a mottled, brownish gray to yellowish gray silt loam. The subsurface extends to a depth of about 18 inches and is a strongly mottled, grayish yellow silt loam. The subsoil to a depth of about 30 inches is a fairly compact, mottled, yellow silt loam, while below this depth it is a friable, slightly mottled, yellow silt loam containing many yellowish red, iron concretions. No carbonates are found to a depth of 40 inches.

Management.—This type, as it occurs in Mercer county, shows slight to medium acidity in the surface soil and ordinarily the degree of acidity increases with increasing depth. The first step in increasing its producing power is to apply sufficient limestone to grow clover, preferably sweet clover, which should be plowed down the spring of the second year in preparation for corn.

Altho no experimental data are available on the fertilization of this soil type, it is suggested that a trial be made of the various phosphates in order to determine which one can be used at the most profit. Results on a light-colored soil with a calcareous subsoil in Lake county indicate that bone meal might be expected to cause sufficient increase in yield to pay a good return on the investment. However, the high price of bone meal suggests that basic slag, acid phosphate, or rock phosphate should be tried first.

It is urged that the problem of phosphate fertilization be given careful study because the phosphorus content of this soil is relatively low. The problem is to determine the kind of phosphate which can be used most profitably and which will at the same time return as much phosphorus to the soil as is lost thru cropping and in other ways. It is understood, of course, that all manure should be carefully conserved and returned to the land, preferably for corn unless a good growth of sweet clover is to be plowed in for corn, in which case the manure may well be used on permanent pasture or for wheat.

Yellow Silt Loam (535)

Somewhat over one-half of the timber soil area of the county is classified as Yellow Silt Loam. This type covers 110 square miles, or about 20 percent of the area of the county. It occurs as a nearly continuous belt on one or both sides of the streams, and is usually more extensively developed on the north side than on the south side. As was noted in the description of Brown Silt Loam, numerous small areas occur, thruout the more rolling portion of the prairie, from which the surface soil has been largely removed by washing. These areas, when sufficiently large, are mapped as Yellow Silt Loam because of their yellow color, even tho they are not timber soil. Many of the slopes in the timber soil areas are very steep and are gullying rapidly, with little or no attempt being made to stop this destruction. This condition is found particularly in the eastern part of the county, where the slopes are generally steeper than in the western part.

Where washing has not been active for a few years, the surface soil of this type is brownish yellow in color to a depth of 3 or 4 inches. Where washing is active, the surface is yellow. Except for the brownish yellow color of the immediate surface, as noted, the soil is very uniformly a yellow silt loam or silty clay loam down to the underlying till. On the steeper slopes, till is fre-

quently exposed. No carbonates are found until the till is penetrated 2 or 3 feet.

Management.—This type should be utilized for the most part for permanent pasture, timber, or orchards. If it is cultivated, particular attention should be given to increasing the organic-matter content and to tillage methods that will help to decrease washing. Much can be accomplished by so planning the rotation that some vegetative covering is on the land a large part of the time. It is frequently possible to control erosion at small cost by constructing broad terraces. For methods which have been used successfully in controlling erosion on this soil type, the reader is referred to the discussion of the Vienna field on page 60 of the Supplement.

Yellow-Gray Fine Sandy Loam (874)

Yellow-Gray Fine Sandy Loam occupies flat ridges between the eroded areas. It covers an area of 13.33 square miles, or 2.43 percent of the area of the county.

The surface, which is about 6 or 7 inches in depth, varies in color from a brownish gray to a grayish yellow, fine sandy loam. The subsurface, extending to a depth of 18 inches, varies from a yellowish gray, fine sandy silt loam to a yellow, fine sandy loam. The subsoil from 18 to 40 inches is a mottled, yellow, fine sandy silt loam in the upper part, and in the lower part a yellow, fine sandy silt loam to a yellow silt loam containing red iron concretions.

Management.—This type is usually slightly acid in the surface and of medium acidity in the subsoil. Carbonates occur at a depth of 5 to 6 feet, as a rule. The organic-matter and nitrogen contents of the type are low. The recommendations made for the management of Yellow-Gray Silt Loam (534) apply also to this type and the reader is referred to that discussion. Yellow-Gray Fine Sandy Loam is an excellent alfalfa soil after the acidity has been taken care of by the addition of about 3 tons of limestone per acre. It is also a good fruit soil.

Yellow Fine Sandy Loam (875)

Yellow Fine Sandy Loam occurs for the most part immediately adjacent to the bottom lands of the streams which are tributary to the Mississippi, and extends two to three miles inland from the Mississippi bluff line. It occurs in the same topographic position as Yellow Silt Loam. It covers an area of 16.18 square miles, or 2.95 percent of the area of the county. This type is badly eroded by gullying and sheet erosion, owing in part to the incoherent character of the soil strata.

The surface varies in depth from 0 to 7 inches, and in color from a yellow to brownish yellow, fine sandy loam. This variation is due in part to differences in erosion and in part to differences in organic-matter content that have resulted from different systems of management. The subsurface and subsoil consist of yellow, fine sandy loam. Till occasionally occurs in the 40-inch section because of the removal of much of the surface blanket of loess.

Management.—This type should be kept in permanent pasture or timber, or should be planted to orchard trees. It is usually not acid and frequently carbonates occur even in the surface soil; there is, however, wide variation in the depth to carbonates.

(c) TERRACE SOILS

The largest area of terrace soil in Mercer county is found south of Eliza creek, between the Mississippi river and the bluffs. North of New Boston the terrace is from 15 to 25 feet higher than the adjacent bottom land to the west. The soil material of this large terrace formation was probably deposited during, and immediately following, the Wisconsin glaciations. Small terraces also occur along the small streams which traverse the county from east to west. These formations have an elevation of 3 to 30 feet above the adjacent bottom lands.

Brown Silt Loam (1526)

Brown Silt Loam, Terrace, covers about 17 square miles, or 3 percent of the total area of the county. It is found for the most part adjacent to the bluffs south of the village of Mannon.

The surface, which is about 8 inches deep, is a brown silt loam with an appreciable percentage of fine sand near the bluff line. The subsurface extends to a depth of about 20 inches and varies in color from brownish yellow to brown and in texture from a silt loam to a fine sandy loam. Some mottling is found in this stratum. The subsoil to a depth of about 32 inches varies from a brownish yellow, sandy loam to a slightly compact, silty clay loam. Below the 32-inch depth it becomes a slightly mottled, bright yellow, silt loam. The depth to gravel is great enough so that this land is not drouthy.

Management.—This type is only slightly acid and will grow red clover successfully without the addition of lime. If alfalfa or sweet clover is to be grown, an application of 2 tons of limestone per acre should be made excepting to low areas or areas which receive some wash from the bluffs. The friable nature of this soil favors the deep growth of roots, and probably no treatment other than the use of legumes, residues, and manures is economically possible.

Brown Fine Sandy Loam (1571)

Brown Fine Sandy Loam, Terrace, occupies about 8 square miles and is found, for the most part, in the vicinity of Mannon.

The surface, which is about 8 inches deep, is a brown, fine sandy loam. The subsurface extends to a depth of about 22 inches and varies from yellowish brown, fine sand to yellow fine sand with no indication of compactness.

Management.—The management requirements of this type are not essentially different from those for the preceding type, Brown Silt Loam, Terrace, (1526). It is more difficult to maintain an adequate supply of fresh organic matter because of the more open nature of the soil. This soil is well adapted to the growth of alfalfa after the small lime requirement has been taken care of.

Brown Sandy Loam (1560)

Brown Sandy Loam, which occupies about 9.43 square miles, or 1.72 percent of the area of the county, is mapped in scattered areas in conjunction with Dune Sand. It varies in topography from flat to undulating owing to its relative position with respect to adjacent types, it being somewhat lower than Dune Sand. Near the bluffs, considerable outwash material has been deposited upon the Brown Sandy Loam.

The surface, which is about 8 or 10 inches in depth, is brown in color and a fine to medium, sandy loam in texture. The subsurface varies from a light brown, fine to medium sand. The subsoil, which begins at about 22 inches, varies from a yellowish brown sand to a yellow sand.

Management.—This type shows a slight to medium acidity. Two or three tons of limestone per acre are necessary for the growth of sweet clover or alfalfa. This soil may be used for growing any of the general farm crops and is also well adapted to trucking. One of the chief considerations in its management is the maintenance of organic matter. Decay is relatively rapid because of the open nature of the soil, and more frequent additions of organic matter must be made than with heavier soils. The subsoil is so coarse that root penetration is probably not very good, and consequently the use of one of the phosphates is advised. No experimental results are available regarding the fertilization of this type.

Dune Sand (1581)

Dune Sand occurs along the outer edge of the Mississippi river terrace south of Eliza creek. It occupies 13 square miles, or about 25 percent of the area of the terrace. The topography is typical of a dune sand region and has been produced by the wind reworking the sand and forming ridges, knobs, and hollows. The organic-matter content of this soil is very low, particularly on the higher areas. The wind is still actively moving the sand, where it is not held by vegetation, forming "blowouts" which may be very small or which may cover areas as large as 80 acres or more. This soil is very uniform thruout the 40-inch section. The immediate surface is a light brown sand or coarse sandy loam, and below this the material is a medium or coarse yellow sand.

Management.—Dune Sand shows a slight to medium acidity. It is not adapted to the production of the ordinary farm crops excepting on the low areas. Sweet clover makes an excellent growth after lime has been applied at the rate of 2 to 3 tons per acre. Following sweet clover, alfalfa does well, tho it is somewhat difficult to get a stand on such a sandy soil. Rye is the best small grain crop to grow, and after the nitrogen deficiency has been met by turning down a legume or by the application of manure, it usually makes very good yields. The use of rock phosphate is not advised because of the adverse results secured with it on the Oquawka field, which is located on the same type of soil. No information is available as to whether one of the more soluble phosphates could be used at a profit, but it is suggested that since this soil is favorable to root penetration, the use of any of the phosphates on it be limited to small areas until their value has been demonstrated.

Brown-Gray Silt Loam On Tight Clay (1528)

Brown-Gray Silt Loam On Tight Clay occurs as a terrace formation along Edwards river north and east of Aledo, and in the Mississippi river terrace east of Keithsburg. The areas along Edwards river slope gently to the bottom land while those in the Mississippi river terrace occur as low, poorly drained areas.

The surface, 6 to 7 inches in depth, varies from a brown silt loam with a gray cast to a grayish brown, sandy silt loam. The subsurface extends to a depth of 18 to 20 inches and is a floury, friable, gray silt loam with some streaks and splotches of yellow. The upper portion of the subsoil, which is a plastic, compact, mottled, grayish drab clay containing brownish red iron concretions, extends to a depth of about 38 inches. Below this stratum of "tight" clay, a friable, drabbish yellow, silty clay loam containing bright red iron concretions occurs.

Management.—The acidity tests indicate that this type is either neutral or only slightly acid. However, unless it is definitely known that the land does not need lime, it is suggested that the county farm adviser be consulted or that the assistance of the Experiment Station be secured. The areas of the type occurring along Edwards river should respond to fertilizer treatment in a manner very similar to the response of slightly undulating Brown Silt Loam. The poorly drained areas occurring in the Mississippi river terrace are very sensitive to unfavorable moisture conditions, and it is questionable whether any fertilizer treatment will cause sufficient increase in yield to pay for its cost unless the drainage is first improved. The trial of about 300 pounds of acid phosphate or of basic slag or half that amount of steamed bone meal, per acre, after plowing and before working down the seed bed for wheat, is suggested. If this is done and sweet clover is seeded in the wheat to be plowed down for corn the following spring, satisfactory crops should result unless unfavorable moisture conditions limit the yields on the poorly drained areas.

Yellow-Gray Silt Loam (1534)

Nearly all the areas of Yellow-Gray Silt Loam, Terrace, are found along Edwards river and Pope creek. The topography varies from flat to undulating, depending on the amount of erosion that has taken place.

The surface, which is about 5 inches in depth, varies in color from a yellowish brown to a yellowish gray, and in texture from a friable silt loam to a fine sandy silt loam. The subsurface, extending to 19 inches in depth, is a yellow, fine sandy loam. The subsoil below 19 inches is a medium, plastic yellow silt loam, changing to a bright yellow silt loam at 36 or 38 inches. This lower portion of the subsoil is splotched with bright red iron concretions.

Management.—The recommendations made for the management of Yellow-Gray Silt Loam, Upland (534), page 14, apply to this type.

Yellow-Gray Sandy Loam (1564)

Yellow-Gray Sandy Loam, Terrace, occurs, for the most part, along the lower courses of Pope creek and Edwards river. It covers only 2.32 square miles.

The surface is about 7 inches in depth and varies from a brownish yellow to yellowish gray, fine sandy loam. The subsurface, extending to about 18 inches in depth, is a mottled, yellow, fine sandy loam. The subsoil to a depth of 34 inches, is a fairly compact, yellow silt loam. Below 34 inches, it is a friable, mottled, yellow silt loam splotched with red iron concretions.

Management.—The recommendations made for Yellow-Gray Fine Sandy Loam, Upland (874), page 16, apply to this type.

Black Clay Loam (1520)

Black Clay Loam, Terrace, is a minor type in this county. It occupies 205 acres and is found only in small tracts. The topography is flat.

The surface soil, which is about 6 inches deep, is a plastic, black clay loam. The subsurface is a plastic, drabbish black to drab, clay loam. From 17 inches down, the subsoil is a plastic, drab clay, splotched with yellow, and below 34 inches, a drabbish blue clay occurs. There are no indications of the presence of alkali or carbonates but acidity tests indicate that limestone is not needed.

Management.—The reader is referred to the discussion of the management of Black Clay Loam, Upland (520), page 14, for suggestions regarding the management of this type.

(d) and (e) SWAMP AND BOTTOM-LAND SOILS[1]

The group designated as Swamp and Bottom-Land soils includes the soils along the streams tributary to the Mississippi and the large area in the Mississippi river bottom proper. The soil is an alluvial formation and is, or has been within recent times, subject to overflow. The Mississippi river bottom land has been practically all leveed, and at the present time very little of the area is subject to overflow.

Deep Brown Silt Loam (1326, 1426)

Deep Brown Silt Loam occurs along the small streams as overflow land, and also in the Mississippi bottom.

The surface, extending to a depth of 5 inches, varies from a brown silt loam to a brown, fine sandy silt loam. The subsurface to about 22 inches in depth varies from a friable, mottled, brownish yellow, fine sandy silt loam to a brownish yellow silt loam. The subsoil varies from a somewhat compact, yellowish gray, silt loam to a somewhat compact, grayish yellow, silty clay loam.

[1] On the soil map of Mercer county, the Swamp and Bottom-Land soils are divided into two groups, the Old and the Late. The basis for this grouping was the supposed length of time which has elapsed since the soil material forming the soils of the two groups was deposited. Subsequent investigations, however, makes it appear that this grouping was not well founded, because the maturity of these soils as revealed by the character of their profiles frequently does not correspond to their supposed age as determined by the length of time which is thought to have elapsed since the soil material forming them was deposited. For this reason the separation of Swamp and Bottom-Land soils into the two groups, Old and Late, is disregarded in the following discussion.

Management.—The portions of this type which are no longer subject to overflow are becoming acid. About 2 tons of limestone per acre is required on these areas to grow sweet clover. The type is well supplied with the elements of plant food and probably will not respond profitably to fertilizer treatment. Attention should be given to increasing the organic-matter content in the non-overflow areas, particularly by plowing down leguminous organic matter, preferably sweet clover.

Mixed Loam (1354, 1454)

Mixed Loam is found along the small streams in the deep loess areas or in locations where conditions were such that much mixed material was deposited. This type cannot be adequately described because of its variations. It is mapped as Mixed Loam because it is made up of a mixture of several types which occur in areas too small to be mapped separately.

The surface varies in color from brown to yellowish gray and in texture from a silt loam to a sandy loam. The subsurface varies in a similar manner in texture, but usually has a yellowish gray color. At a depth of about 22 inches a brownish yellow to yellow, coarse sand is frequently found.

Management.—Much of the area covered by this type is subject to overflow and no treatment other than good tillage is recommended.

Black Clay Loam (1320)

Black Clay Loam, Bottom Land, which occupies about 230 acres of the county, is located in the basin of Henderson creek.

The surface, which is about 7 inches in depth, is a plastic, black clay loam. The subsurface, extending to a depth of about 15 inches, is a plastic, drabbish, black clay loam. The subsoil is a drab clay loam or clay.

Management.—This type is alkaline, as shown by the presence of snail shells. Thoro underdrainage should be provided and fresh organic matter should be plowed down at frequent intervals. If corn shows injury from the alkali, this difficulty may be lessened or entirely overcome by plowing down second-year sweet clover in the spring. The sweet clover should be plowed at least two weeks before corn planting time. The use of 75 to 100 pounds per acre of a potash salt at the time of, or just before, planting corn will counteract the injurious effects of the alkali.

Drab Clay (1415)

Drab Clay is found in the Mississippi river bottom north of New Boston. In topography it is flat, and it is difficult to farm both in wet and dry weather because of its fine texture. Since dredges have been built and pumping stations established, the water-table level has been lowered so that nearly all of the area can now be farmed.

The surface, which is about 6 inches in depth, varies from a very plastic, drab clay loam to a drab clay. The subsurface to about 20 inches in depth is a heavy, plastic, fairly compact, drab clay. The subsoil is also a very heavy,

plastic, drab clay, being somewhat of a "water logged" soil. Some fine sand is mixed with the clay below a depth of 36 to 40 inches.

Management.—This soil does not need lime and is well supplied with the elements of plant food, excepting nitrogen. The only way to improve its unfavorable physical properties is to be careful not to work it when too wet or too dry, and to make frequent additions of fresh organic matter. This type is productive but requires careful management to prevent its getting into very bad physical condition.

Drab Clay Loam (1421)

Drab Clay Loam is found in the bottom land in conjunction with Drab Clay. It has the same topography and similar drainage as Drab Clay.

The surface is about 4 inches in depth and varies from a heavy brown clay loam to a plastic drab clay loam. The subsurface is a plastic, drab clay loam, which changes gradually at about 22 inches to a plastic, grayish drab, clay subsoil.

Management.—The recommendations for management made for the preceding type, Drab Clay (1415), apply to this type. It is an easier soil to work than Drab Clay; however, it very easily gets into bad physical condition unless it is carefully handled and the organic-matter content is maintained.

Brown Sandy Loam (1460)

Brown Sandy Loam, Bottom Land, occurs in scattered areas thruout the Mississippi bottom and along Pope creek in the vicinity of Keithsburg. It is undulating in topography and is usually 3 or 4 feet higher than the surrounding soil areas. This type is a favorite for locating farm buildings because it is better drained and less muddy than surrounding areas. The Brown Sandy Loam along Pope creek is of a different origin from that occurring in the Mississippi bottom, being formed from material washed down from the upland lying to the east.

The surface, which is about 5 inches in depth, is a coarse-grained, brown sandy loam. The subsurface and subsoil are practically indistinguishable and vary from yellowish brown to yellow, coarse-grained river sand.

Management.—Brown Sandy Loam, Bottom Land, is very similar to Brown Sandy Loam, Terrace (1560), and should be managed in the same way. The discussion of the management of this type is found on page 18.

Black Mixed Loam (1450)

Black Mixed Loam occupies only a small percentage of the area of the county, covering about 450 acres. It is flat in topography, swampy, and poorly drained.

The surface varies from 7 to 10 inches in depth. It is black in color and varies in texture from sandy loam to clay loam. The subsurface is drabbish black in color, gradually becoming more drab with increasing depth. Considerable variation occurs in the texture of both the subsurface and the subsoil.

Management.—This type is well supplied with all the elements of plant food and is not acid. It becomes a productive soil when drained.

Mixed Sandy Loam (1463)

Mixed Sandy Loam is of minor importance. Only 173 acres of it occur in Mercer county and it is found only in very small tracts.

This type varies in color and texture as do all "mixed" types. In the main, it is a sandy soil with a light brown surface and a yellow or yellowish brown subsurface and subsoil. The type has been formed by the sandy material washing into low places. Frequently the original floor of the old pond or slough is found at less than 40 inches below the present surface.

Management.—This type should be handled in the same way as Mixed Loam (1354, 1454), and the reader is referred to the discussion on page 21.

Deep Peat (1401)

The total area of Deep Peat in Mercer county is very small, comprizing only 64 acres. It occurs in narrow strips bordering the sand terrace; its formation resulted from the continuously wet condition produced by seepage water from the terrace.

The peat is black and well decomposed. It rests on drab clay, which occurs at a depth of 34 to 42 inches below the surface.

Management.—Good drainage should be provided. This can be effected on most of the areas, as the clay is near enough to the surface to provide a bed for the tile. Peat is usually deficient in potassium, and it has been found profitable to supply this element in the form of a potash salt in amounts of 100 to 200 pounds per acre for the corn crop.

Muck On Clay (1413)

Only 51 acres of Muck On Clay are found in Mercer county. It occurs in connection with the Deep Peat and was formed in the same way but contains a higher percentage of clay particles. It is a black, slightly plastic, highly organic material to a depth of about 20 inches, where it rests on black clay. At a depth of about 34 inches, the clay becomes drab in color and is very plastic.

Management.—Drainage is probably all that is needed to make this type productive.

River Sand (1480)

River Sand occurs as small sand ridges usually formed by wind action. It is a soil type of small importance. There are only 51 acres in the county and it is of low agricultural value. It should be handled in the same way as Dune Sand (1581), page 18.

APPENDIX

EXPLANATIONS FOR INTERPRETING THE SOIL SURVEY

CLASSIFICATION OF SOILS

In order to intelligently interpret the soil maps, the reader must understand something of the method of soil classification upon which the survey is based. Without going far into details the following paragraphs are intended to furnish a brief explanation of the general plan of classification used.

The type is the unit of classification and each type has definite characteristics. In establishing types, the following factors are taken into account: the character of the horizons composing the soil as to depth and thickness, physical composition, structure, organic-matter content, color, reaction, and carbonate content; the topography; the native vegetation; and the geological origin of the soil.[1]

Not infrequently areas are encountered in which type characters are not distinctly developed or in which they show considerable variation. When these variations are considered to have sufficient significance, type separations are made whenever the areas involved are sufficiently large. Because of the almost infinite variability occurring in soils, one of the exacting tasks of the soil surveyor is to determine the degree of variation which is allowable for any given type.

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[1] Since some of the terms used in designating the factors which are taken into account in establishing soil types are technical in nature, the following explanations are introduced:

Horizon. A layer or stratum of soil which differs discernibly from those adjacent in color, texture, structure, chemical composition, or a combination of these characteristics, is called an horizon.

Depth and Thickness. The horizons or layers which make up the soil profile vary in depth and thickness. These variations are distinguishing features in the separation of soils into types.

Physical Composition. The physical composition, sometimes referred to as "texture," is a most important feature in characterizing a soil. The texture depends upon the relative proportions of the following physical constituents: clay, silt, fine sand, sand, gravel, stones, and organic material.

Structure. The term "structure" has reference to the aggregation of particles within the soil mass and carries such qualifying terms as open, granular, compact.

Organic-Matter Content. The organic matter of soil is derived largely from plant tissue and it exists in a more or less advanced stage of decomposition. Organic matter constitutes the predominating constituent in certain soils of swampy formation.

Color. Color is determined to a large extent by the proportion of organic matter, but at the same time it is modified by the mineral constituents, especially by iron compounds.

Reaction. The term "reaction" refers to the chemical state of the soil with respect to acid or alkaline condition. It also involves the idea of degree, as strongly acid or strongly alkaline.

Carbonate Content. The carbonate content has reference to the calcium carbonate (limestone) present, which in some cases may be associated with magnesium or other carbonates. The depth at which carbonates are found may become a very important factor in determining the soil type.

Topography. Topography has reference to the lay of the land, as level, rolling, hilly, etc.

Native Vegetation. The vegetation or plant growth before being disturbed by man, as prairie grasses and forest trees, is a feature frequently recognized in determining soil types.

Geological Origin. Geological origin involves the idea of character of rock materials composing the soil as well as the method of formation of the soil.

Classifying Soil Types.—In the system of classification used, the types fall first into four general groups based upon their geological relationships; namely, upland, terrace, swamp and bottom land, and residual. These groups may be subdivided into prairie soils and timber soils, altho as a matter of fact this subdivision is applied in the main only to the upland group. These terms are all explained in the foregoing part of the report in connection with the description of the particular soil types.

Naming and Numbering Soil Types.—In the Illinois soil survey a system of nomenclature is used which is intended to make the type name convey some idea of the nature of the soil. Thus the name "Yellow-Gray Silt Loam" carries in itself a more or less definite description of the type. It should not be assumed, however, that this system of nomenclature makes it possible to devise type names which are adequately descriptive, because the profile of mature soils is usually made up of four or more horizons and it is impossible to describe each horizon in the type name. The color and texture of the surface soil are usually included in the type name and when material such as sand, gravel, or rock lies at a depth of less than 30 inches, the fact is indicated by the word "on," and when its depth exceeds 30 inches, by the word "over"; for example, Brown Silt Loam On Gravel, and Brown Silt Loam Over Gravel.

As a further step in systematizing the listing of the soils of Illinois, recognition is given to the location of the types with respect to the geological areas in which they occur. According to a geological survey made many years ago, the state has been divided into seventeen areas with respect to geological formation and, for the purposes of the soil survey, each of these areas has been assigned an index number. The names of the areas together with their general location and their corresponding index numbers are given in the following list.

000	*Residual,* soils formed in place thru disintegration of rocks, and also rock outcrop
100	*Unglaciated,* comprizing three areas, the largest being in the south end of the state
200	*Illinoisan moraines,* including the moraines of the Illinoisan glaciations
300	*Lower Illinoisan glaciation,* covering nearly the south third of the state
400	*Middle Illinoisan glaciation,* covering about a dozen counties in the west-central part of the state
500	*Upper Illinoisan glaciation,* covering about fourteen counties northwest of the middle Illinoisan glaciation
600	*Pre-Iowan glaciation,* but now believed to be part of the upper Illinoisan
700	*Iowan glaciation,* lying in the central northern end of the state
800	*Deep loess areas,* including a zone a few miles wide along the Wabash, Illinois, and Mississippi rivers
900	*Early Wisconsin moraines,* including the moraines of the early Wisconsin glaciation
1000	*Late Wisconsin moraines,* including the moraines of the late Wisconsin glaciation
1100	*Early Wisconsin glaciation,* covering the greater part of the northeast quarter of the state
1200	*Late Wisconsin glaciation,* lying in the northeast corner of the state
1300	*Old river-bottom and swamp lands,* found in the older or Illinoisan glaciation
1400	*Late river-bottom and swamp lands,* those of the Wisconsin and Iowan glaciations
1500	*Terraces,* bench or second bottom lands, and gravel outwash plains
1600	*Lacustrine deposits,* formed by Lake Chicago, the enlarged glacial Lake Michigan

For further information regarding these geological areas the reader is referred to the general map published in Bulletins 123 and 193.

Another set of index numbers is assigned to the classes of soils as based upon physical composition. The following list contains the names of these classes with their corresponding index numbers.

Index Number Limits	Class Names
0 to 9	Peats
10 to 12	Peaty loams
13 to 14	Mucks
15 to 19	Clays
20 to 24	Clay loams
25 to 49	Silt loams
50 to 59	Loams
60 to 79	Sandy Loams
80 to 89	Sands
90 to 94	Gravelly loams
95 to 97	Gravels
98	Stony loams
99	Rock outcrop

As a convenient means of designating types and their location with respect to the geological areas of the state, each type is given a number made up of a combination of the index numbers explained above. This number indicates the type and the geological area in which it occurs. The geological area is always indicated by the digits of the order of hundreds while the balance of the number designates the type. To illustrate: the number 1126 means Brown Silt Loam in the early Wisconsin glaciation, 434 means Yellow-Gray Silt Loam of the middle Illinoisan glaciation. These numbers are especially useful in designating very small areas on the map and as a check in reading the colors.

A complete list of the soil types occurring in each county, along with their corresponding type numbers and the area covered by each type, will be found in the respective county soil reports in connection with the maps.

SOIL SURVEY METHODS

Mapping of Soil Types.—In conducting the soil survey, the county constitutes the unit of working area. The field work is done by parties of two to four men each. The field season extends from early in April to Thanksgiving. During the winter months the men are engaged in preparing a copy of the soil map to be sent to the lithographer, a copy for the use of the county farm adviser until the printed map is available, and a third copy for use in the office in order to preserve the original official map in good condition.

An accurate base map for field use is necessary for soil mapping. These maps are prepared on a scale of one inch to the mile, the official data of the original or subsequent land survey being used as the basis in their construction. Each surveyor is provided with one of these base maps, which he carries with him in the field; and the soil type boundaries, together with the streams, roads, railroads, canals, town sites, and rock and gravel quarries are placed in their proper location upon the map while the mapper is on the area. With the rapid development of road improvement during the past few years, it is almost inevitable that some recently established roads will not appear on the published soil map. Similarly, changes in other artificial features will occasionally occur in the interim between the preparation of the map and its publication. The detail or minimum size of areas which are shown on the map varies somewhat, but in general a soil type if less than five acres in extent is not shown.

A soil auger is carried by each man with which he can examine the soil to a depth of 40 inches. An extension for making the auger 80 inches long is taken

by each party, so that the deeper subsoil may be studied. Each man carries a compass to aid in keeping directions. Distances along roads are measured by a speedometer or other measuring device, while distances in the field away from the roads are measured by pacing.

Sampling for Analysis—After all the soil types of a county have been located and mapped, samples representative of the different types are collected for chemical analysis. The samples for this purpose are usually taken in three depths; namely, 0 to 6⅔ inches, 6⅔ to 20 inches, and 20 to 40 inches, as explained in connection with the discussion of the analytical data on page 6.

PRINCIPLES OF SOIL FERTILITY

Probably no agricultural fact is more generally known by farmers and landowners than that soils differ in productive power. A fact of equal importance, not so generally recognized, is that they also differ in other characteristics such as response to fertilizer treatment and to management.

The soil is a dynamic, ever-changing, exceedingly complex substance made up of organic and inorganic materials and teeming with life in the form of microorganisms. Because of these characteristics, the soil cannot be considered as a reservoir into which a given quantity of an element or elements of plant food can be poured with the assurance that it will respond with a given increase in crop yield. In a similar manner it cannot be expected to respond with perfect uniformity to a given set of management standards. To be productive a soil must be in such condition physically with respect to structure and moisture as to encourage root development; and in such condition chemically that injurious substances are not present in harmful amounts, that a sufficient supply of the elements of plant food become available or usable during the growing season, and that lime materials are present in sufficient abundance favorable for the growth of the higher plants and of the beneficial microorganisms. Good soil management under humid conditions involves the adoption of those tillage, cropping, and fertilizer treatment methods which will result in profitable and permanent crop production on the soil type concerned.

The following paragraphs are intended to state in a brief way some of the principles of soil management and treatment which are fundamental to profitable and continued productivity.

CROP REQUIREMENTS WITH RESPECT TO PLANT-FOOD MATERIALS

Ten different elements of plant food are essential for the growth and formation of every plant. These elements are: *carbon, oxygen, hydrogen, nitrogen, phosphorus, sulfur, potassium, magnesium, calcium, and iron.* Some seasons in central Illinois are sufficiently favorable to allow the production of at least 50 bushels of wheat per acre, 100 bushels of corn, 100 bushels of oats, and 4 tons of clover hay. When such crops, growing under favorable climatic and cultural conditions and uninjured by disease or insect pests, are not produced the failure is due to unfavorable soil conditions, which may result from poor drainage, poor physical condition, or from an actual deficiency in one or more of the elements of plant food.

TABLE A.—PLANT-FOOD ELEMENTS IN COMMON FARM CROPS[1]

Produce: Kind	Amount	Nitrogen	Phosphorus	Sulfur	Potassium	Magnesium	Calcium	Iron
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Wheat, grain......	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat, straw.....	1 ton	10.00	1.60	2.80	18.00	1.60	3.80	.60
Corn, grain.......	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn stover.......	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs........	1 ton	4.00	.....	.....	4.00	.....	.....	.....
Oats, grain.......	1 bu.	.66	.11	.06	.16	.04	.02	.01
Oat straw........	1 ton	12.40	2.00	4.14	20.80	2.80	6.00	1.12
Clover seed.......	1 bu.	1.75	.50	.....	.75	.25	.13	.....
Clover hay.......	1 ton	40.00	5.00	3.28	30.00	7.75	29.25	1.00
Soybean seed.....	1 bu.	3.22	.39	.27	1.26	.15	.14	.....
Soybean hay......	1 ton	43.40	4.74	5.18	35.48	13.84	27.56	.....
Alfalfa hay.......	1 ton	52.08	4.76	5.96	16.64	8.00	22.26	.....

[1] These data are brought together from various sources. Some allowance must be made for the exactness of the figures because samples representing the same kind of crop or the same kind of material frequently exhibit considerable variation.

Table A shows the requirements of some of our most common field crops with respect to the seven plant-food elements furnished by the soil. The figures show the weight in pounds of the various elements contained in a bushel or in a ton, as the case may be. From these data the amount of any element removed from an acre of land by a crop of a given yield can easily be computed.

PLANT-FOOD SUPPLY

Of the ten elements of plant food, three (carbon, oxygen, and hydrogen) are secured from air and water, and seven from the soil. *Nitrogen,* one of these seven elements obtained from the soil by all plants, may also be secured from the air by the class of plants known as legumes, in case the amount liberated from the soil is insufficient; but even these plants, which include only the clovers, peas, beans, and vetches among our common agricultural plants, are dependent upon the soil for the other six elements (phosphorus, potassium, magnesium, calcium, iron, and sulfur), and they also utilize the soil nitrogen so far as it becomes soluble and available during their period of growth.

The vast difference with respect to the supply of these essential plant-food elements in different soils is well brought out in the data of the Illinois soil survey. For example, it has been found that the nitrogen in the surface 6⅔ inches, which represents the plowed stratum, varies in amount from 180 pounds per acre to more than 35,000 pounds. In like manner the phosphorus content varies from about 420 to 4,900 pounds, and the potassium ranges from 1,530 to about 58,000 pounds. Similar variations are found in all of the other essential plant-food elements of the soil.

With these facts in mind it is easy to understand how a deficiency of one of these elements of plant food may become a limiting factor of crop production. When an element becomes so reduced in quantity as to become a limiting factor

TABLE B.—PLANT-FOOD ELEMENTS IN MANURE, ROUGH FEEDS, AND FERTILIZERS[1]

Material	Pounds of plant food per ton of material		
	Nitrogen	Phosphorus	Potassium
Fresh farm manure	10	2	8
Corn stover	16	2	17
Oat straw	12	2	21
Wheat straw	10	2	18
Clover hay	40	5	30
Cowpea hay	43	5	33
Alfalfa hay	50	4	24
Sweet clover (water-free basis)[2]	80	8	28
Dried blood	280	...	...
Sodium nitrate	310	...	...
Ammonium sulfate	400	...	...
Raw bone meal	80	180	...
Steamed bone meal	20	250	...
Raw rock phosphate	...	250	...
Acid phosphate	...	125	...
Potassium chlorid	...	...	850
Potassium sulfate	...	...	850
Kainit	...	...	200
Wood ashes[3] (unleached)	...	10	100

[1] See footnote to Table A.
[2] Young second year's growth ready to plow under as green manure.
[3] Wood ashes also contain about 1,000 pounds of lime (calcium carbonate) per ton.

of production, then we must look for some outside source of supply. Table B is presented for the purpose of furnishing information regarding the quantity of some of the more important plant-food elements contained in materials most commonly used as sources of supply.

LIBERATION OF PLANT FOOD

The chemical analysis of the soil gives the invoice of plant-food elements actually present in the soil strata sampled and analyzed, but the rate of liberation is governed by many factors, some of which may be controlled by the farmer, while others are largely beyond his control. Chief among the important controllable factors which influence the liberation of plant food are the choice of crops to be grown, the use of limestone, and the incorporation of organic matter. Tillage, especially plowing, also has a considerable effect in this connection.

Feeding Power of Plants.—Different species of plants exhibit a very great diversity in their ability to obtain plant food directly from the insoluble minerals of the soil. As a class, the legumes—especially such biennial and perennial legumes as red clover, sweet clover, and alfalfa—are endowed with unusual power to assimilate from mineral sources such elements as calcium and phosphorus, converting them into available forms for the crops that follow. For this reason it is especially advantageous to employ such legumes in connection with the application of limestone and rock phosphate. Thru their growth and subsequent decay large quantities of the mineral elements are liberated for

the benefit of the cereal crops which follow in the rotation. Moreover, as an effect of the deep-rooting habit of these legumes, mineral plant-food elements are brought up and rendered available from the vast reservoirs of the lower subsoil.

Effect of Limestone.—Limestone corrects the acidity of the soil and supplies calcium, thus encouraging the development not only of the nitrogen-gathering bacteria which live in the nodules on the roots of clover, cowpeas, and other legumes, but also the nitrifying bacteria, which have power to transform the unavailable organic nitrogen into available nitrate nitrogen. At the same time, the products of this decomposition have power to dissolve the minerals contained in the soil, such as potassium and magnesium compounds.

Organic Matter and Biological Action.—Organic matter may be supplied thru animal manures, consisting of the excreta of animals and usually accompanied by more or less stable litter; and by plant manures, including green-manure crops and cover crops plowed under, and also crop residues such as stalks, straw, and chaff. The rate of decay of organic matter depends largely upon its age, condition, and origin, and it may be hastened by tillage. The chemical analysis shows correctly the total organic carbon, which constitutes, as a rule, but little more than half the organic matter; so that 20,000 pounds of organic carbon in the plowed soil of an acre corresponds to nearly 20 tons of organic matter. But this organic matter consists largely of the old organic residues that have accumulated during the past centuries because they were resistant to decay, and 2 tons of clover or cowpeas plowed under may have greater power to liberate plant-food materials than the 20 tons of old, inactive organic matter. The history of the individual farm or field must be depended upon for information concerning recent additions of active organic matter, whether in applications of farm manure, in legume crops, or in sods of old pastures.

The condition of the organic matter of the soil is indicated to some extent by the ratio of carbon to nitrogen. Fresh organic matter recently incorporated with the soil contains a very much higher proportion of carbon to nitrogen than do the old resistant organic residues of the soil. The proportion of carbon to nitrogen is higher in the surface soil than in the corresponding subsoil, and in general this ratio is wider in highly productive soils well charged with active organic matter than in very old, worn soils badly in need of active organic matter.

The organic matter furnishes food for bacteria, and as it decays certain decomposition products are formed, including much carbonic acid, some nitrous acid, and various organic acids, and these acting upon the soil have the power to dissolve the essential mineral plant foods, thus furnishing available phosphates, nitrates, and other salts of potassium, magnesium, calcium, etc., for the use of the growing crop.

Effect of Tillage.—Tillage, or cultivation, also hastens the liberation of plant-food elements by permitting the air to enter the soil. It should be remembered, however, that tillage is wholly destructive, in that it adds nothing whatever to the soil, but always leaves it poorer, so far as plant-food materials are concerned. Tillage should be practiced so far as is necessary to prepare a suitable seed bed for root development and also for the purpose of killing weeds, but more than

this is unnecessary and unprofitable; and it is much better actually to enrich the soil by proper applications of limestone, organic matter, and other fertilizing materials, and thus promote soil conditions favorable for vigorous plant growth, than to depend upon excessive cultivation to accomplish the same object at the expense of the soil.

PERMANENT SOIL IMPROVEMENT

According to the kind of soil involved, any comprehensive plan contemplating a permanent system of agriculture will need to take into account some of the following considerations.

The Application of Limestone

The Function of Limestone.—In considering the application of limestone to land it should be understood that this material functions in several different ways, and that a beneficial result may therefore be attributable to quite diverse causes. Limestone provides calcium, of which certain crops are strong feeders. It corrects acidity of the soil, thus making for some crops a much more favorable environment as well as establishing conditions absolutely required for some of the beneficial legume bacteria. It accelerates nitrification and nitrogen fixation. It promotes sanitation of the soil by inhibiting the growth of certain fungous diseases, such as corn-root rot. Experience indicates that it modifies either directly or indirectly the physical structure of fine-textured soils, frequently to their great improvement.

Thus, working in one or more of these different ways, limestone often becomes the key to the improvement of worn lands. Remarkable success has been experienced with limestone used in conjunction with sweet clover in the reclamation of abandoned hill land which has been ruined thru erosion.

Amounts to Apply.—If the soil is acid, usually at least 2 tons per acre of ground limestone should be applied as an initial treatment. Continue to apply limestone from time to time according to the requirement of the soil as indicated by the tests described below, or until the most favorable conditions are established for the growth of legumes, using preferably at times magnesian limestone ($CaCO_3MgCO_3$), which contains both calcium and magnesium and has slightly greater power to correct soil acidity, ton for ton, than the ordinary calcium limestone ($CaCO_3$). On strongly acid soils, or on land being prepared for alfalfa, 4 or 5 tons per acre of ground limestone may well be used for the first application.

How to Ascertain the Need for Limestone.—One of the most reliable indications as to whether a soil needs limestone is the character of the growth of certain legumes, particularly sweet clover and alfalfa. These crops do not thrive in acid soils. Their successful growth, therefore, indicates the lack of sufficient acidity in the soil to be harmful. In case of their failure to grow the soil should be tested for acidity as described below. A very valuable test for ascertaining the need of a soil for limestone is found in the potassium thiocyanate test for soil acidity. It is of value to make the test for carbonates along with the acidity test. Limestone is calcium carbonate, while dolomite is the combined carbonate of calcium and magnesium. The natural occurrence of these carbonates in the

soil is sufficient assurance that no limestone is needed, and the acidity test will be negative. On lands which have been treated with limestone, however, the surface soil may give a positive test for carbonates, due to the presence of undecomposed pieces of limestone, and at the same time a positive test for acidity may be secured. Such a result means either that insufficient limestone has been added, or that it has not been in the soil long enough to entirely correct the acidity. In making these tests, it is desirable to examine samples of soil from different depths, since carbonates may be present, even in abundance, below a surface stratum that is acid. Following are the directions for making the tests:

The Potassium Thiocyanate Test for Acidity. This test is made with a 4-percent solution of potassium thiocyanate in alcohol—4 grams of potassium thiocyanate in 100 cubic centimeters of 95-percent alcohol (not denatured). When a small quantity of soil shaken up in a test tube with this solution gives a red color the soil is acid and limestone should be applied. If the solution remains colorless the soil is not acid. An excess of water interferes with the reaction. In testing, therefore, the sample should be about as dry as when the soil is in good tillable condition. The conditions for a prompt reaction require a temperature that is comfortably warm.

The Hydrochloric Acid Test for Carbonates. Make a shallow cup of a ball of soil and pour into it a few drops of hydrochloric (muriatic) acid, prepared by diluting the concentrated acid with an equal volume of water. The presence of limestone or some other carbonates will be shown by the appearance of gas bubbles within 2 or 3 minutes, producing foaming or effervescence. The absence of carbonates in a soil is not in itself evidence that the soil is acid or that limestone should be applied, but it indicates that the confirmatory potassium thiocyanate test should be carried out.

The Nitrogen Problem

Nitrogen presents the greatest practical soil problem in American agriculture. Four important reasons for this are: its increasing deficiency in most soils; its cost when purchased on the open market; its removal in large amounts by crops; and its loss from soils thru leaching. Nitrogen usually costs from four to five times as much per pound as phosphorus. A 100-bushel crop of corn requires 150 pounds of nitrogen for its growth, but only 23 pounds of phosphorus. The loss of nitrogen from soils may vary from a few pounds to over one hundred pounds per acre, depending upon the treatment of the soil, the distribution of rainfall, and the protection afforded by growing crops.

An inexhaustible supply of nitrogen is present in the air. Above each acre of the earth's surface there are about sixty-nine million pounds of atmospheric nitrogen. The nitrogen above one square mile weighs twenty million tons, an amount sufficient to supply the entire world for four or five decades. This large supply of nitrogen in the air is the one to which the world must eventually turn.

There are two methods of collecting the inert nitrogen gas of the air and combining it into compounds that will furnish products for plant growth. These are the chemical and the biological fixation of the atmospheric nitrogen. Farmers have at their command one of these methods. By growing inoculated legumes, nitrogen may be obtained from the air, and by plowing under more than the roots of those legumes, nitrogen may be added to the soil.

Inasmuch as legumes are worth growing for purposes other than the fixation of atmospheric nitrogen, a considerable portion of the nitrogen thus gained may be considered a by-product. Because of that fact, it is questionable whether the chemical fixation of nitrogen will ever be able to replace the simple method

of obtaining atmospheric nitrogen by growing inoculated legumes in the production of our great grain and forage crops.

It may well be kept in mind that the following amounts of nitrogen are required for the produce named:

1 bushel of oats (grain and straw) requires 1 pound of nitrogen.
1 bushel of corn (grain and stalks) requires 1½ pounds of nitrogen.
1 bushel of wheat (grain and straw) requires 2 pounds of nitrogen.
1 ton of timothy contains 24 pounds of nitrogen.
1 ton of clover contains 40 pounds of nitrogen.
1 ton of cowpea hay contains 43 pounds of nitrogen.
1 ton of alfalfa contains 50 pounds of nitrogen.
1 ton of average manure contains 10 pounds of nitrogen.
1 ton of young sweet clover, at about the stage of growth when it is plowed under as green manure, contains, on water-free basis, 80 pounds of nitrogen.

The roots of clover contain about half as much nitrogen as the tops, and the roots of cowpeas contain about one-tenth as much as the tops. Soils of moderate productive power will furnish as much nitrogen to clover (and two or three times as much to cowpeas) as will be left in the roots and stubble. In grain crops, such as wheat, corn, and oats, about two-thirds of the nitrogen is contained in the grain and one-third in the straw or stalks.

The Phosphorus Problem

The element phosphorus is an indispensable constituent of every living cell. It is intimately connected with the life processes of both plants and animals, the nuclear material of the cells being especially rich in this element.

The phosphorus content of the soil is dependent upon the origin of the soil. The removal of phosphorus by continuous cropping slowly reduces the amount of this element in the soil available for crop use, unless its addition is provided for by natural means, such as overflow, or by agricultural practices, such as the addition of phosphatic fertilizers and rotations in which deep-rooting, leguminous crops are frequently grown.

It should be borne in mind in connection with the application of phosphate, or of any other fertilizing material, to the soil, that no benefit can result until the need for it has become a limiting factor in plant growth. For example, if there is already present in the soil sufficient available phosphorus to produce a forty-bushel crop, and the nitrogen supply or the moisture supply is sufficient for only forty bushels, or less, then extra phosphorus added to the soil cannot increase the yield beyond this forty-bushel limit.

There are several different materials containing phosphorus which are applied to land as fertilizer. The more important of these are bone meal, acid phosphate, natural raw rock phosphate, and basic slag. Obviously that carrier of phosphorus which gives the most economical returns, as considered from all standpoints, is the most suitable one to use. Altho this matter has been the subject of much discussion and investigation the question still remains unsettled. Probably there is no single carrier of phosphorus that will prove to be the most economical one to use under all circumstances because so much depends upon soil conditions, crops grown, length of haul, and market conditions.

Bone meal, prepared from the bones of animals, appears on the market in two different forms, raw and steamed. Raw bone meal contains, besides the

phosphorus, a considerable percentage of nitrogen which adds a useless expense if the material is purchased only for the sake of the phosphorus. As a source of phosphorus, steamed bone meal is preferable to raw bone meal. Steamed bone meal is prepared by extracting most of the nitrogenous and fatty matter from the bones, thus producing a more nearly pure form of calcium phosphate containing about 10 to 12 percent of the element phosphorus.

Acid phosphate is produced by treating rock phosphate with sulfuric acid. The two are mixed in about equal amounts; the product therefore contains about one-half as much phosphorus as the rock phosphate itself. Acid phosphate also contains besides phosphorus, sulfur, which is likewise an element of plant food. The phosphorus in acid phosphate is more readily available for absorption by plants than that of raw rock phosphate. Acid phosphate of good quality should contain 6 percent or more of the element phosphorus.

Rock phosphate, sometimes called floats, is a mineral substance found in vast deposits in certain regions. The phosphorus in this mineral exists chemically as tri-calcium phosphate and a good grade of the rock should contain 12½ percent, or more, of the element phosphorus. The rock should be ground to a powder, fine enough to pass thru a 100-mesh sieve, or even finer.

The relative cheapness of raw rock phosphate, as compared with the treated or acidulated material, makes it possible to apply for equal money expenditure considerably more phosphorus per acre in this form than in the form of acid phosphate, the ratio being, under the market conditions of the past several years, about 4 to 1. That is to say, under these market conditions, a dollar will purchase about four times as much of the element phosphorus in the form of rock phosphate as in the form of acid phosphate, which is an important consideration if one is interested in building up a phosphorus reserve in the soil. As explained above, more very carefully conducted comparisons on various soil types under various cropping systems are needed before definite statements can be given as to which form of phosphate is most economical to use under any given set of conditions.

Basic slag, known also as Thomas phosphate, is another carrier of phosphorus that might be mentioned because of its considerable usage in Europe and eastern United States. Basic slag phosphate is a by-product in the manufacture of steel. It contains a considerable proportion of basic material and therefore it tends to influence the soil reaction.

Rock phosphate may be applied at any time during a rotation, but it is applied to the best advantage either preceding a crop of clover, which plant seems to possess an unusual power for assimilating the phosphorus from raw phosphate, or else at a time when it can be plowed under with some form of organic matter such as animal manure or green manure, the decay of which serves to liberate the phosphorus from its insoluble condition in the rock. It is important that the finely ground rock phosphate be intimately mixed with the organic material as it is plowed under.

In using acid phosphate or bone meal in a cropping system which includes wheat, it is a common practice to apply the material in the preparation of the wheat ground. It may be advantageous, however, to divide the total amount

to be used and apply a portion to the other crops of the rotation, particularly to corn and to clover.

The Potassium Problem

Our most common soils, which are silt loams and clay loams, are well stocked with potassium, altho it exists largely in a slowly soluble form. Such soils as sands and peats, however, are likely to be low in this element. On such soils this deficiency may be supplied by the application of some potassium salt, such as potassium sulfate, potassium chlorid, kainit, or other potassium compound, and in many instances this is done at great profit.

From all the facts at hand it seems, so far as our great areas of common soils are concerned, that, with a few exceptions, the potassium problem is not one of addition but of liberation. The Rothamsted records, which represent the oldest soil experiment fields in the world, show that for many years other soluble salts have had practically the same power as potassium to increase crop yields in the absence of sufficient decaying organic matter. Whether this action relates to supplying or liberating potassium for its own sake, or to the power of the soluble salt to increase the availability of phosphorus or other elements, is not known, but where much potassium is removed, as in the entire crops at Rothamsted, with no return of organic residues, probably the soluble salt functions in both ways.

Further evidence on this matter is furnished by the Illinois experiment field at Fairfield, where potassium sulfate has been compared with kainit both with and without the addition of organic matter in the form of stable manure. Both sulfate and kainit produced a substantial increase in the yield of corn, but the cheaper salt—kainit—was just as effective as the potassium sulfate, and returned some financial profit. Manure alone gave an increase similar to that produced by the potassium salts, but the salts added to the manure gave very little increase over that produced by the manure alone. This is explained in part, perhaps, because the potassium removed in the crops is mostly returned in the manure if properly cared for, and perhaps in larger part because the decaying organic matter helps to liberate and hold in solution other plant-food elements, especially phosphorus.

In laboratory experiments at the Illinois Experiment Station, it has been shown that potassium salts and most other soluble salts increase the solubility of the phosphorus in soil and in rock phosphate; also that the addition of glucose with rock phosphate in pot-culture experiments increases the availability of the phosphorus, as measured by plant growth, altho the glucose consists only of carbon, hydrogen, and oxygen, and thus contains no limiting element of plant food.

In considering the conservation of potassium on the farm it should be remembered that in average live-stock farming the animals destroy two-thirds of the organic matter and retain one-fourth of the nitrogen and phosphorus from the food they consume, but that they retain less than one-tenth of the potassium; so that the actual loss of potassium in the products sold from the farm, either in grain farming or in livestock farming, is negligible on land containing 25,000 pounds or more of potassium in the surface 6⅔ inches.

The Calcium and Magnesium Problem

When measured by the actual crop requirements for plant food, magnesium and calcium are more limited in some Illinois soils than potassium. But with these elements we must consider also the loss by leaching.

The annual loss of limestone from the soil depends, of course, upon a number of factors aside from those which have to do with climatic conditions. Among these factors may be mentioned the character of the soil, the kind of limestone, its condition of fineness, the amount present, and the sort of farming practiced. Because of this variation in the loss of lime materials from the soil, it is impossible to prescribe a fixed practice in their renewal that will apply universally. The tests for acidity and carbonates described above, together with the behavior of such lime-loving legumes as alfalfa and sweet clover, will serve as general indicators for the frequency of applying limestone and the amount to use on a given field.

Limestone has a positive value on some soils for the plant food which it supplies, in addition to its value in correcting soil acidity and in improving the physical condition of the soil. Ordinary limestone (abundant in the southern and western parts of the state) contains nearly 800 pounds of calcium per ton; while a good grade of dolomitic limestone (the more common limestone of northern Illinois) contains about 400 pounds of calcium and 300 pounds of magnesium per ton. Both of these elements are furnished in readily available form in ground dolomitic limestone.

The Sulfur Question

In considering the relation of sulfur in a permanent system of soil fertility it is important to understand something of the cycle of transformations that this element undergoes in nature. Briefly stated this is as follows:

Sulfur exists in the soil in both organic and inorganic forms, the former being gradually converted to the latter form thru bacterial action. In this inorganic form sulfur is taken up by plants which in their physiological processes change it once more into an organic form as a constituent of protein. When these plant proteins are consumed by animals, the sulfur becomes a part of the animal protein. When these plant and animal proteins are decomposed, either thru bacterial action, or thru combustion, as in the burning of coal, the sulfur passes into the atmosphere or into the soil solution in the form of sulfur dioxid gas. This gas unites with oxygen and water to form sulfuric acid, which is readily washed back into the soil by the rain, thus completing the cycle, from soil—to plants and animals—to air—to soil.

In this way sulfur becomes largely a self-renewing element of the soil, altho there is a considerable loss from the soil by leaching. Observations taken at the Illinois Agricultural Experiment Station show that 40 pounds of sulfur per acre are brought into the soil thru the annual rainfall. With a fair stock of sulfur, such as exists in our common types of soil, and with an annual return, which of itself would more than suffice for the needs of maximum crops, the maintenance of an adequate sulfur supply presents little reason at present for serious concern. There are regions, however, where the natural stock of sulfur

in the soil is not nearly so high and where the amount returned thru rainfall is small. Under such circumstances sulfur soon becomes a limiting element of crop production, and it will be necessary sooner or later to introduce this substance from some outside source. Investigation is now under way to determine to what extent this situation may apply to conditions in Illinois.

Physical Improvement of Soils

In the management of most soil types, one very important matter, aside from proper fertilization, tillage, and drainage, is to keep the soil in good physical condition, or good tilth. The constituent most important for this purpose is organic matter. Organic matter in producing good tilth helps to control washing of soil on rolling land, raises the temperature of drained soil, increases the moisture-holding capacity of the soil, slightly retards capillary rise and consequently loss of moisture by surface evaporation, and helps to overcome the tendency of some soils to run together badly.

The physical effect of organic matter is to produce a granulation or mellowness, by cementing the fine soil particles into crumbs or grains about as large as grains of sand, which produces a condition very favorable for tillage, percolation of rainfall, and the development of plant roots.

Organic matter is undergoing destruction during a large part of the year and the nitrates produced in its decomposition are used for plant growth. Altho this decomposition is necessary, it nevertheless reduces the amount of organic matter, and provision must therefore be made for maintaining the supply. The practical way to do this is to turn under the farm manure, straw, cornstalks, weeds, and all or part of the legumes produced on the farm. The amount of legumes needed depends upon the character of the soil. There are farms, especially grain farms, in nearly every community where all legumes could be turned under for several years to good advantage.

Manure should be spread upon the land as soon as possible after it is produced, for if it is allowed to lie in the barnyard several months as is so often the case, from one-third to two-thirds of the organic matter will be lost.

Straw and cornstalks should be turned under, and not burned. There is considerable evidence indicating that on some soils undecomposed straw applied in excessive amount may be detrimental. Probably the best practice is to apply the straw as a constituent of well-rotted stable manure. Perhaps no form of organic matter acts more beneficially in producing good tilth than cornstalks. It is true, they decay rather slowly, but it is also true that their durability in the soil is exactly what is needed in the production of good tilth. Furthermore, the nitrogen in a ton of cornstalks is one and one-half times that of a ton of manure, and a ton of dry cornstalks incorporated in the soil will ultimately furnish as much humus as four tons of average farm manure. When burned, however, both the humus-making material and the nitrogen are lost to the soil.

It is a common practice in the corn belt to pasture the cornstalks during the winter and often rather late in the spring after the frost is out of the ground. This trampling by stock sometimes puts the soil in bad condition for working. It becomes partially puddled and will be cloddy as a result. If tramped too

late in the spring, the natural agencies of freezing and thawing and wetting and drying, with the aid of ordinary tillage, fail to produce good tilth before the crop is planted. Whether the crop is corn or oats, it necessarily suffers, and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats, the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling which is unfavorable to physical, chemical, and biological processes. The effect becomes worse if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Systems of Crop Rotations

In a program of permanent soil improvement one should adopt at the outset a good rotation of crops, including, for the reasons discussed above, a liberal use of legumes. No one can say in advance for every particular case what will prove to be the best rotation of crops, because of variation in farms and farmers and in prices for produce.

Following are a few suggested rotations, applicable to the corn belt, which may serve as models or outlines to be modified according to special circumstances.

Six-Year Rotations

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth Year —Wheat (with clover), or grass and clover
Sixth year —Clover, or clover and grass

Of course there should be as many fields as there are years in the rotation. In grain farming, with small grain grown the third and fifth years, most of the unsalable products should be returned to the soil, and the clover may be clipped and left on the land or returned after threshing out the seed (only the clover seed being sold the fourth and sixth years) ; or, in live-stock farming, the field may be used three years for timothy and clover pasture and meadow if desired. The system may be reduced to a five-year rotation by cutting out either the second or the sixth year, and to a four-year system by omitting the fifth and sixth years, as indicated below.

Five-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover, or clover and grass)
Third year —Clover, or clover and grass
Fourth year —Wheat (with clover), or clover and grass
Fifth year —Clover, or clover and grass

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover)

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover
Fifth year —Wheat (with clover)

The last rotation mentioned above allows legumes to be seeded four times. Alfalfa may be grown on a sixth field for five or six years in the combination rotation, alternating between two fields every five years, or rotating over all the fields if moved every six years.

Four-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover)
Third year —Clover
Fourth year —Wheat (with clover)

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover)
Fourth year —Clover

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover

First year —Wheat (with clover)
Second year —Clover
Third year —Corn
Fourth year —Oats (with clover)

Alfalfa may be grown on a fifth field for four or eight years, which is to be alternated with one of the four; or the alfalfa may be moved every five years, and thus rotated over all five fields every twenty-five years.

Three-Year Rotations

First year —Corn
Second year —Oats or wheat (with clover)
Third year —Clover

First year —Wheat (with clover)
Second year —Corn
Third year —Cowpeas or soybeans

By allowing the clover, in the last rotation mentioned, to grow in the spring before preparing the land for corn, we have provided a system in which legumes grow on every acre every year. This is likewise true of the following suggested two-year system:

Two-Year Rotations

First year —Oats or wheat (with sweet clover)
Second year —Corn

Altho in this two-year rotation either oats or wheat is suggested, as a matter of fact, by dividing the land devoted to small grain, both of these crops can be grown simultaneously, thus providing a three-crop system in a two-year cycle.

It should be understood that in all of the above suggested cropping systems it may be desirable in some cases to substitute rye for the wheat or oats. Or, in some cases, it may become desirable to divide the acreage of small grain and grow in the same year more than one kind. In all of these proposed rotations the word *clover* is used in a general sense to designate either red clover, alsike clover, or sweet clover. The value of sweet clover, especially as a green manure for building up depleted soils, as well as a pasture and hay-crop, is becoming thoroly established, and its importance in a crop-rotation program may well be emphasized.

SUPPLEMENT: EXPERIMENT FIELD DATA

(Results from Experiment Fields on Soil Types Similar to Those Occurring in Mercer County)

In the earlier reports of this series it was the practice to incorporate in the body of the report the results of certain experiment fields, for the purpose of illustrating the possibilities of improving the soil of various types. The information carried by such data must, naturally, be considered more or less tentative. As the fields grow older new facts develop, which in some instances may call for the modification of former recommendations. It has therefore seemed desirable to separate this experiment field data from the more permanent information of the soil survey, and embody the same in the form of a supplement to the soil report proper, thus providing a convenient arrangement for possible future revisions as further data accumulate.

The University of Illinois has conducted altogether about fifty soil experiment fields in different sections of the state and on various types of soil. Altho some of these fields have been discontinued, the majority are still in operation. It is the present purpose to report the summarized results from certain of these fields located on types of soil described in the accompanying soil report.

A few general explanations at this point, which apply to all the fields, will relieve the necessity of numerous repetitions in the following pages.

Size and Arrangement of Fields

The soil experiment fields vary in size from less than two acres up to 40 acres or more. They are laid off into series of plots, the plots commonly being either one-fifth or one-tenth acre in area. Each series is occupied by one kind of crop. Usually there are several series so that a crop rotation can be carried on with every crop represented every year.

Two Farming Systems Provided

On many of the fields the treatment provides for two distinct systems of farming, livestock farming and grain farming.

In the livestock system, stable manure is used to furnish organic matter and nitrogen. The amount applied to a plot is based upon the amount that can be produced from crops raised on that plot.

In the grain system no animal manure is used. The organic matter and nitrogen are applied in the form of plant manures, including the plant residues produced, such as cornstalks, straw from wheat, oats, clover, etc., along with leguminous catch crops plowed under. It is the plan in this latter system to remove from the land, in the main, only the grain and seed produced, except in the case of alfalfa, that crop being harvested for hay the same as in the livestock system.

Definite Crop Rotations Followed

Crops which are of interest in the respective localities are grown in definite rotations. The most common rotation used is wheat, corn, oats, and clover; and often these crops are accompanied by alfalfa growing on a fifth series. In the grain system a legume catch crop, usually sweet clover, is included, which is seeded on the young wheat in the spring and plowed under in the fall or in the following spring in preparation for corn. If the red clover crop fails, soybeans are substituted.

Standard Soil Treatments Used

The treatment applied to the plots has, for the most part, been standardized according to a rather definite system, altho deviations from this system occur now and then, particularly in the older fields.

Following is a brief explanation of this standard system of treatment.

Animal Manures.—Animal manures, consisting of excreta from animals, with stable litter, are spread upon the respective plots in amounts proportionate to previous crop yields, the applications being made in the preparation for corn.

Plant Manures.—Crop residues produced on the land, such as stalks, straw, and chaff, are returned to the soil, and in addition a green-manure crop of sweet clover is seeded in small grain to be plowed under in preparation for corn. (On plots where limestone is lacking the sweet clover seldom survives.) This practice is designated as the *residues system.*

Mineral Manures.—The yearly acre-rates of application have been: for limestone, 1,000 pounds; for raw rock phosphate, 500 pounds; and for potassium, the equivalent of 200 pounds of kainit. The initial application of limestone has usually been 4 tons per acre.

Explanation of Symbols

0 = Untreated land or check plots
M = Manure (animal)
R = Residues (from crops, and includes legumes used as green manure)
L = Limestone
P = Phosphorus
K = Potassium (usually in the form of kainit)
N = Nitrogen (usually in the form contained in dried blood)
( ) = Parentheses enclosing figures signify tons of hay, as distinguished from bushels of seed

In discussions of this sort of data, financial profits or losses based upon assigned market values are frequently considered. However, in view of the erratic fluctuations in market values—especially in the past few years—it seems futile to attempt to set any prices for this purpose that are at all satisfactory. The yields are therefore presented with the thought that with these figures at hand the financial returns from a given practice can readily be computed upon the basis of any set of market values that the reader may choose to apply.

TABLE 1.—URBANA FIELD, MORROW PLOTS

Crop Yields in Soil Experiments—Bushels or (tons) per acre

Year	Soil treatment applied	Corn every year	Two-year rotation		Three-year rotation		
		Corn	Corn	Oats	Corn	Oats	Clover
1879–87	None	....	....	....	....	....	....
1888	None	54.3	49.5	....	....	48.6	....
1889	None	43.2	....	37.4	....	....	(4.04)
1890	None	48.7	54.3	....	....	....	(1.51)
1891	None	28.6	33.2	....	....	....	(1.46)
1892	None	33.1	....	37.2	70.2	....	....
1893	None	21.7	29.6	....	34.1	....	....
1894	None	34.8	....	57.2	....	65.1	....
1895	None	42.2	41.6	....	....	22.2	....
1896	None	62.3	....	34.5	....	....	....
1897	None	40.1	47.0	....	....	....	....
1898	None	18.1	....	....	....	....	....
1899	None	50.1	44.4	....	53.5	....	....
1900	None	48.0	....	41.5	....	....	....
1901	None	23.7	33.7	....	34.3	....	....
1902	None	60.2	....	56.3	....	54.6	....
1903	None	26.0	35.9	....	....	....	(1.11)
1904	None	21.5	....	17.5	55.3	....	....
1904	MLP	17.1	....	25.3	72.7	....	....
1905	None	24.8	50.0	....	....	42.3	....
1905	MLP	31.4	44.9	....	....	50.6	....
1906	None	27.1	....	34.7	....	....	(1.42)[1]
1906	MLP	35.8	....	52.4	....	....	(1.74)[1]
1907	None	29.0	47.8	....	80.5	....	....
1907	MLP	48.7	87.6	....	93.6	....	....
1908	None	13.4	....	32.9	....	40.0	....
1908	MLP	28.0	....	45.0	....	44.4	....
1909	None	26.6	33.0	....	....	....	(.65)[2]
1909	MLP	31.6	64.8	....	....	....	(1.73)[3]
1910	None	35.9	....	33.8	58.6	....	....
1910	MLP	54.6	....	59.4	83.3	....	....
1911	None	21.9	28.6	....	....	20.6	....
1911	MLP	31.5	46.3	....	....	38.0	....
1912	None	43.2	....	55.0	....	....	16.3[1]
1912	MLP	64.2	....	81.0	....	....	20.0[1]
1913	None	19.4	29.2	....	33.8	....	....
1913	MLP	32.0	25.0	....	47.8	....	....
1914	None	31.6	....	33.6	....	39.6	....
1914	MLP	39.4	....	58.2	....	60.4	....
1915	None	40.0	49.0	....	....	....	24.2[1]
1915	MLP	66.0	81.2	....	....	....	27.1[1]
1916	None	11.2	....	37.5	27.8	....	....
1916	MLP	10.8	....	64.7	40.6	....	....
1917	None	40.0	48.4	....	....	68.4	....
1917	MLP	67.0	81.4	....	....	86.9	....
1918	None	13.6	....	27.2	....	....	(2.58)
1918	MLP	32.6	....	59.3	....	....	(4.04)
1919	None	24.0	30.8	....	52.2	....	....
1919	MLP	43.4	66.2	....	70.8	....	....
1920	None	28.2	....	37.2	....	52.2	....
1920	MLP	54.4	....	51.6	....	69.7	....
1921	None	19.8	30.6	....	....	....	(.26)[4]
1921	MLP	42.2	68.4	....	....	....	(1.33)[5]
1922	None	24.6	....	39.3	49.2	....	....
1922	MLP	39.4	....	55.8	65.3	....	....
1923	None	15.0	17.2	....	....	53.4	....
1923	MLP	31.4	46.4	....	....	66.6	....
1924	None	28.0	....	36.0	....	....	(1.83)
1924	MLP	38.0	....	68.5	....	....	(4.42)

[1] Soybeans. [2] In addition to the hay, .64 bushel of seed was harvested. [3] In addition to the hay, 1.17 bushels of seed were harvested. [4] In addition to the hay, .53 bushel of seed was harvested. [5] In addition to the hay, .85 bushel of seed was harvested.

EXPERIMENTS ON BROWN SILT LOAM

Several experiment fields have been conducted on Brown Silt Loam at various locations in Illinois. Those located at the University have been in operation the longest and they serve well to illustrate the principles involved in the maintenance and improvement of this type of soil.

The Morrow Plots

So far as known, the oldest soil experiment field in the United States is located on Brown Silt Loam of the early Wisconsin glaciation, on the campus of the University of Illinois. According to official records the experiments on this field were authorized in 1879. The plots are now known as the Morrow Plots, in honor of George E. Morrow, who was at that time Professor of Agriculture.

The Morrow series now consists of three plots divided into halves, and the halves are subdivided into quarters. On one plot, corn is grown continuously; on the second, corn and oats are grown in rotation; and on the third, corn, oats, and clover are rotated. The north half of each plot has had no fertilizing material applied from the beginning of the experiments, while the south half has been treated since 1904. Besides farm manure, phosphorus has been applied in two different forms: rock phosphate to the southwest quarter at the rate of 600 pounds, and steamed bone meal to the southeast quarter at the rate of 200 pounds per acre per year up to 1919, when the rock phosphate was increased sufficiently to bring up the total amount applied to four times the quantity of bone meal applied. At the same time the rate of subsequent application of both forms of phosphorus was reduced to one-fourth the quantity, or to 200 pounds of rock phosphate and 50 pounds of bone meal per acre per year. In 1904 ground limestone was applied at the rate of 1,700 pounds per acre to the south half of each plot, and in 1918 a further application was made at the rate of 5 tons per acre.

Table 1 gives the yearly records of the crop yields from the Morrow plots, and Table 2 presents the results in summarized form.

Summarizing the data from these Morrow plots into two periods, with the second period beginning in 1904, when the treatment began on the half-plots, some interesting comparisons may be made. In the first place we find in the untreated, continuous corn plot a marked decrease in the second period in the average yield of corn, amounting to one-third of the crop. In the two-year rotation there is a decrease in both corn and oats production, while the averages for the three-year system show an increase in corn yield and decreases in oats and

TABLE 2.—URBANA FIELD, MORROW PLOTS: GENERAL SUMMARY

Average Annual Yields—Bushels or (tons) per acre

Years	Soil treatment applied	Corn every year	Two-year rotation		Three-year rotation		
			Corn	Oats	Corn	Oats	Clover
		16 crops	*9 crops*	*6 crops*	*4 crops*	*4 crops*	*4 crops*
1888 to 1903	None........	39.7	41.0	44.0	48.0	47.6	(2.03)
		21 crops	*10 crops*	*11 crops*	*7 crops*	*7 crops*	*7 crops*[1]
1904 to 1924	None........	25.7	36.5	35.0	51.1	45.2	(1.71)
	MLP........	39.9	61.2	56.5	67.7	59.5	(2.86)

[1]Including all legume crops evaluated as clover hay.

clover. Unfortunately the numbers of crops included in these last averages are too small to warrant positive conclusions.

The increase brought about by soil treatment stands out in all cases, showing the possibility not only of restoring but also of greatly improving the productive power of this land that has been so abused by continuous cropping without fertilization.

The Davenport Plots

Another set of plots on the University campus at Urbana, forming a more extensive series than the Morrow plots, but of more recent origin, are the Davenport plots. Here provision is made for each crop in the rotation to be represented every year. These plots were laid out in 1895, but special soil treatment was not begun until 1901. They now comprize five series of ten plots each, and each series constitutes a ''field'' in a crop rotation system.

From 1901 to 1911 three of the series were in a three-year rotation system of corn, oats, and clover, while the remaining two series rotated in corn and oats. In 1911 these two systems were combined into a five-series field, with a crop rotation of wheat, corn, oats, and clover, with alfalfa on a fifth field. The alfalfa occupies one series during a rotation of the other four crops, shifting to another series in the fifth year, thus completing the cycle of all series in twenty-five years.

The soil treatment applied to these plots has been as follows:

Legume cover crops were seeded in the corn at the last cultivation on Plots 2, 4, 6, and 8, from 1902 to 1907, but the growth was small and the effect, if any, was to decrease the returns from the regular crops. Crop residues (**R**) have been returned to these same plots since 1907. These consist of stalks and straw, and all legumes except alfalfa hay and the seed of clover and soybeans. Beginning in 1918 a modification of the practice was made in that one cutting of the red clover crop is harvested as hay. In conjunction with these residues a catch crop of sweet clover grown with the wheat is plowed under.

Manure (**M**) was applied preceding corn, at the rate of 2 tons per acre in 1905, 1906, and 1907; subsequently as many tons have been applied as there have been tons of air-dry produce harvested from the respective plots.

Lime (**L**) was applied on Plots 4 to 10 at the rate per acre of 250 pounds of air-slaked lime in 1902, and 600 pounds of limestone in 1903. No further application was made until 1911, when the system of cropping was changed. Since that time applications of limestone have been made at the yearly rate of one-half ton per acre.

Phosphorus (**P**) was applied on Plots 6 to 9 at the yearly rate of 25 pounds per acre in 200 pounds of steamed bone meal; but beginning with 1908 rock phosphate at the rate of 600 pounds per acre per year was substituted for the bone meal on one-half of each of these plots. These applications continued until 1918, when adjustments were begun, first to make the rate of application of rock phosphate four times that of the bone meal, and finally to reduce the amounts of these materials to 200 pounds of rock phosphate and 50 pounds of bone meal per acre yearly. The usual practice has been to apply and plow under at one time all phosphorus and potassium required for the rotation.

Potassium (**K**) has been applied on Plots 8 and 9 in connection with the bone meal and rock phosphate, at the yearly rate of 42 pounds per acre, and mainly as potassium sulfate.

On Plot 10 about five times as much manure and phosphorus are applied as on the other plots, but this "extra heavy" treatment was not begun until 1906, only the usual amounts of lime, phosphorus, and potassium having been applied in previous years. The purpose in making these heavy applications is to try to determine the climatic possibilities in crop yields by removing the limitations of inadequate amounts of the elements of plant food.

It will be observed that the applications described above provide for the two rather distinct systems of farming already described. The *grain system,* in which animal manure is not produced and where the organic matter is provided by the direct return to the soil of crop residues along with legumes, is exemplified in Plots 2, 4, 6, and 8; and the *livestock system,* in which farm manure is utilized for soil enrichment, is represented in the corresponding Plots 3, 5, 7, and 9.

Table 3 shows a summary of the results obtained on the Davenport plots beginning with the year 1911, when the present cropping system was introduced.

When used in conjunction with phosphorus, the crop residues and the manure appear about equally effective; but where phosphorus is not applied, manure has been decidedly more effective than residues, under the conditions of the experiment. It should be observed, however, in this connection, that the plowing under of clover is a very essential feature of the residues system, and that, as a matter of fact during the fourteen years there were five clover failures, when soybeans were substituted. Perhaps with a more reliable biennial legume than red clover, the results would have been more favorable for this system.

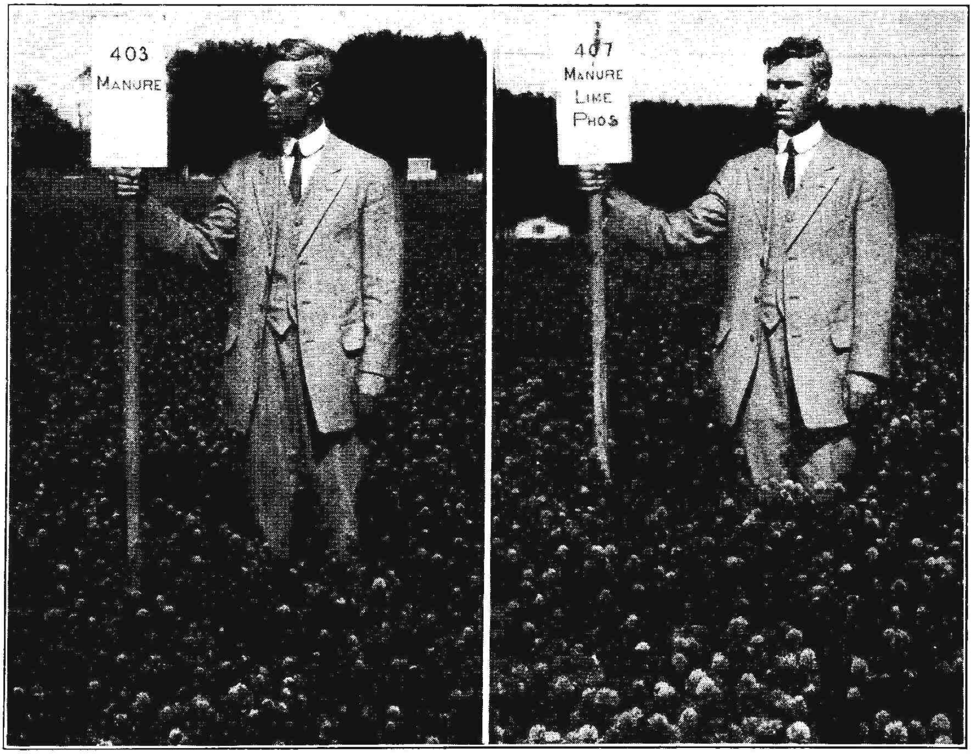
By comparing Plots 2 and 3 with Plots 4 and 5, it is found that limestone has had a beneficial effect on all crops. What the financial profit amounts to depends obviously upon the market value of the crops and the cost of the limestone.

TABLE 3.—URBANA FIELD, DAVENPORT PLOTS

Average Annual Yields 1911-1924—Bushels or (tons) per acre

Plot	Soil treatment applied	Corn *14 crops*	Oats *15 crops*[1]	Wheat *14 crops*	Clover *9 crops*		Soybeans *5 crops*	Alfalfa *12 crops*
1	0	53.1	53.2	26.6	(1.96)	....	(1.47)	(2.64)
2	R	53.8	54.5	29.3	(.40)	1.23	19.8	(2.76)
3	M	64.3	62.6	29.9	(2.25)		(1.62)	(2.71)
4	RL	62.9	57.8	32.4	(.58)	1.40	20.3	(2.99)
5	ML	69.0	64.8	34.8	(2.78)		(1.67)	(3.24)
6	RLP	69.8	71.3	42.2	(.72)	1.53	23.5	(4.10)
7	MLP	71.2	70.7	41.1	(3.39)		(1.97)	(4.19)
8	RLPK	70.9	73.1	40.0	(.73)	1.20	25.5	(4.30)
9	MLPK	69.0	72.3	40.0	(3.39)		(2.20)	(4.22)
10	Mx5LPx5	65.1	72.0	40.1	(3.11)	....	(2.22)	(4.26)

[1]Including a nurse crop of oats, grown with alfalfa seeding in 1924.



Manure
Yield: 1.43 tons per acre

Manure, limestone, phosphorus
Yield: 2.90 tons per acre

FIG. 1.—CLOVER ON THE DAVENPORT PLOTS IN 1913

Comparing Plots 4 and 5 with Plots 6 and 7, respectively, there is found in all cases an increase in crop yield as a result of adding phosphorus. The effect on wheat is especially pronounced. Where limestone and phosphorus are applied in addition to the crop residues, an increase of 15.6 bushels of wheat, over the yield of the untreated land, has been obtained as a fourteen-year average.

The effect of adding potassium to the treatment is of much interest. Plots 8 and 9 are similar to Plots 6 and 7, respectively, except that potassium has been applied to the former. The small gains appearing in certain cases are counterbalanced by losses in others, and on the whole, potassium treatment has not been profitable on these plots.

No benefit appears as the result of the extra-heavy applications of manure and phosphorus on Plot 10. In fact the corn yields are noticeably less here than on the plots receiving the normal applications of these materials.

The University South Farm

On the University South Farm, at Urbana, several series of plots devoted primarily to variety testing and other crop-production experiments are so laid out as to show the effects of certain soil treatments that have been applied. Several different systems of crop rotation are employed and the crops are so handled as to exemplify the two general systems of farming, grain and livestock.

TABLE 4.—URBANA FIELD, SOUTH FARM
SOUTHWEST ROTATION: SERIES 100, 200, 400[1]

Average Annual Yields 1908-1919—Bushels or (tons) per acre

Soil treatment applied[6]	Corn 9 crops	Oats[3] 9 crops	Wheat[3] 8 crops	Clover[4] 3 crops	Soybeans[2] 7 crops
R	50.8	48.1	26.4	1.11	15.5[5]
RP	62.3	51.9	41.0	1.05	17.3[5]
RPL	60.5	57.2	41.8	.64	16.4[5]
M	57.6	52.2	28.5	(2.00)	(1.27)
MP	64.3	55.4	43.1	(2.86)	(1.51)
MPL	64.1	59.6	43.9	(1.77)	(1.58)
Gains for Phosphate					
RP over R	11.5	3.8	14.6	−.06	1.8
MP over M	6.7	3.2	14.6	(.86)	(.24)
Gains for Limestone					
RPL over RP	−1.8	5 3	.8	−.41	−.9
MPL over MP	−.2	4.2	.8	(−.09)	(−.07)

[1]Results from Series 300 are omitted on account of variation in soil type.
[2]Soybeans when clover fails.
[3]Only seven crops with limestone.
[4]Only one crop with limestone.
[5]Average of five crops.
[6]All phosphorus plots received ½ ton per acre of limestone in 1903.

The results presented in Table 4 are those of the Southwest rotation.

Residues plowed under
Yield: 35.2 bushels per acre

Residues and rock phosphate
Yield: 50.1 bushels per acre

FIG. 2.—WHEAT ON THE UNIVERSITY SOUTH FARM IN 1911

The cropping program on this series includes wheat, corn, oats, and clover, with the substitution of soybeans when clover fails. This rotation system is regarded as one well adapted to this type of soil under Illinois conditions.

In looking over the results in Table 4 it is observed that the yields in general do not run quite so high in the residues system as in the manure system; but as observed in the case of the Davenport series mentioned above, the residues system has been handicapped to some extent thru frequent clover failure.

The results showing the effect of phosphorus treatment are of interest. As the carrier of phosphorus rock phosphate has been employed. The figures show an increase in yield wherever phosphate has been applied except in the single case of the clover seed. In the corn, wheat, and clover the increase is very pronounced.

Limestone has been used on this field only in conjunction with phosphate, and it seems to have produced little or no effect. The small differences appearing as the result of adding limestone can well be ascribed to the natural plot variation. The comparisons, may be somewhat impaired, however, due to a possible residual effect of a small application of limestone made in 1903 to all the phosphate plots.

The Aledo Field

An experiment field on Brown Silt Loam is located in Mercer county just west of Aledo. This field has been in operation since 1910. From its physical aspects this field should be well adapted to experimental work, the land being unusually uniform in topography and in soil profile.

The diagram presented as Fig. 4 shows the arrangement of plots on the Aledo field. There are two general systems of plots and they are designated as the major and the minor systems. The major system comprizes four series (numbered 100, 200, 300, 400) made up of 10 plots each. The plots were handled substantially as described for standard treatment until 1922, when a number of changes to be mentioned below were introduced. The rotation practiced was wheat, corn, oats, and clover, until 1923, when the cropping program also was modified.

The yields of all crops on this system of plots since the beginning of the experiments up to 1923 are recorded in Table 5, and a summary of the results is presented in Table 6. This summary shows the average annual yields obtained for the period beginning when complete soil treatment came into sway and ending with the year 1922, after which the crop rotation was changed.

It will be noted that soybeans have been substituted several times for red clover when the latter failed. For the present purpose only the grain crops are considered in the summary. The lower section of Table 6 gives comparisons in terms of crop increases intended to indicate the effect of the different fertilizing materials applied.

In looking over these results we may observe first the beneficial effect of animal manure in all crops, but especially marked in the corn. This suggests the advisability of carefully conserving and regularly applying all stable manure. Residues, alone, have as yet shown little effect.

Where limestone has been applied, there is usually a small increase in

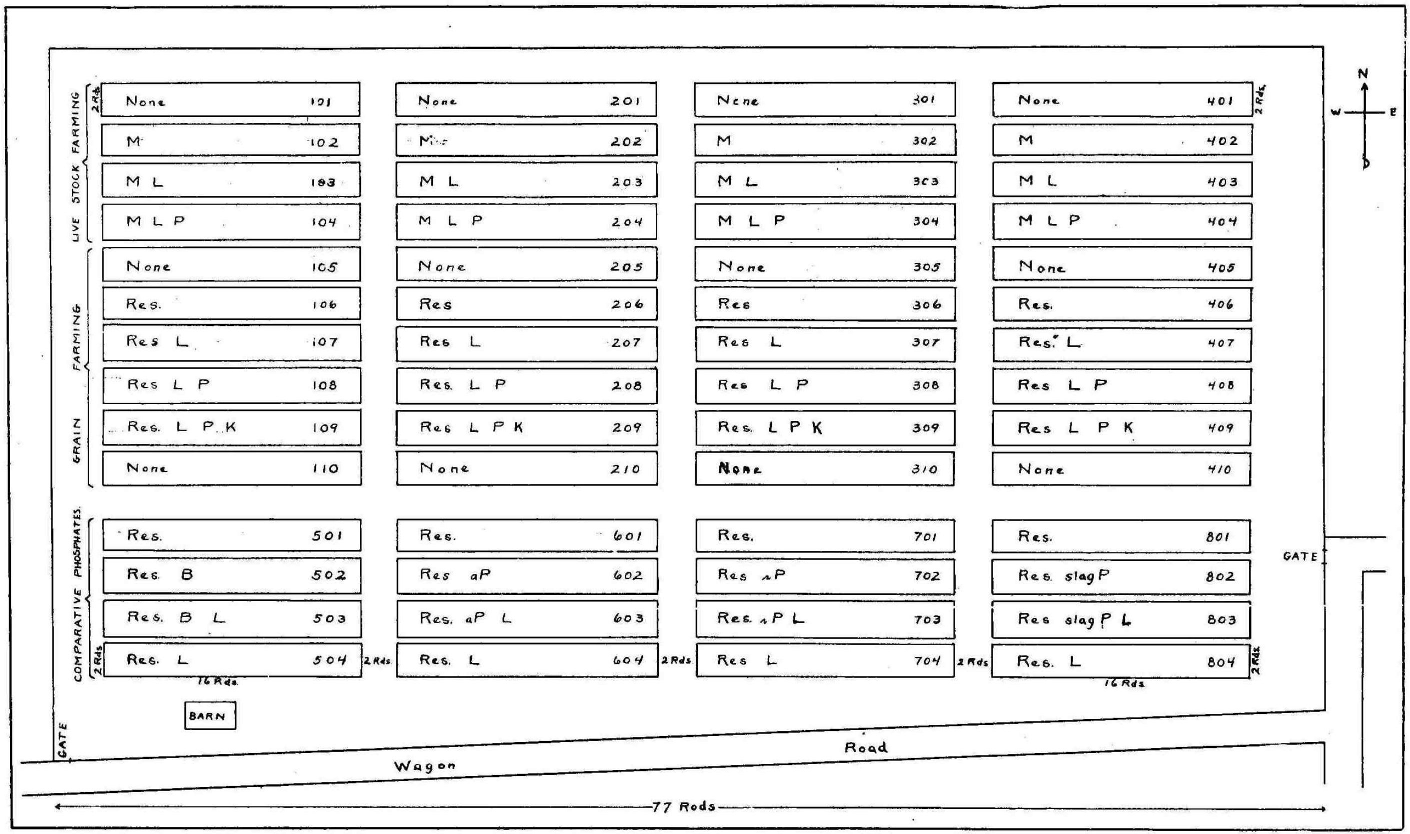


FIG. 3.—DIAGRAM SHOWING ARRANGEMENT OF PLOTS ON THE ALEDO EXPERIMENT FIELD

TABLE 5.—ALEDO FIELD

ROTATION: WHEAT, CORN, OATS, CLOVER

Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1910 Oats[5]	1911 Corn[1]	1912 Oats[2]	1913 Clover[2]	1914 Wheat[3]	1915 Corn	1916 Oats	1917 Clover	1918 Wheat	1919 Corn	1920 Oats	1921 Soybeans	1922 Wheat	1923 Corn
101	0..........	60.2	69.3	49.2	(3.02)	27.0	52.8	51.9	(1.46)	32.6	60.9	67.5	21.3	28.4	47.5
102	M.........	37.5	68.1	38.1	(3.16)	29.2	67.7	62.5	(2.23)	32.2	85.5	73.4	16.2	29.2	75.9
103	ML........	60.6	67.6	40.8	(3.29)	31.8	67.9	65.8	(2.24)	34.5	75.6	65.8	15.1	32.5	80.5
104	MLP......	60.8	65.1	41.4	(3.55)	34.6	72.2	71.9	(2.38)	39.2	77.1	84.4	13.1	35.1	78.8
105	0..........	48.1	70.7	40.3	2.33	30.0	56.8	56.2	.50	31.8	62.2	84.2	15.9	25.4	64.9
106	R.........	55.0	64.6	40.6	2.42	30.6	58.3	52.5	.58	35.7	71.7	71.7	15.1	25.0	74.2
107	RL........	53.4	66.8	45.0	2.67	33.1	61.5	57.8	1.25	38.6	79.4	72.3	17.6	30.7	89.0
108	RLP.......	46.1	69.2	46.9	1.92	36.1	69.1	60.0	1.75	43.7	78.6	77.7	19.4	34.8	87.8
109	RLPK.....	61.4	65.8	43.1	2.50	32.7	63.1	62.8	1.33	40.7	78.0	79.7	19.8	34.6	88.7
110	0..........	53.1	67.1	45.2	(3.06)	26.8	55.6	58.1	(1.93)	30.3	60.1	63.4	17.5	29.3	58.6
		Soybeans[5]	Wheat[4]	Corn	Oats	Clover	Wheat	Corn	Oats	Clover	Wheat	Corn	Oats	Clover	Corn
201	0..........	10.7	14.5	69.7	46.4	(1.03)	34.4	40.9	67.3	(3.48)	36.1	64.6	49.8	(2.22)	71.7
202	M.........	11.0	14.7	78.8	43.4	(1.40)	40.8	50.9	68.3	(3.71)	34.5	73.8	57.0	(2.99)	83.5
203	ML........	15.3	12.3	78.2	45.8	(2.54)	49.2	60.0	73.8	(4.36)	26.3	68.3	52.2	(3.21)	89.8
204	MLP......	13.7	9.7	83.1	45.9	(2.59)	50.0	57.9	53.6	(3.87)	27.3	75.4	49.2	(2.94)	97.8
205	0..........	13.8	13.4	71.6	46.2	1.17	42.5	45.3	72.2	(3.01)	33.1	63.0	53.0	(2.77)	70.9
206	R.........	14.2	13.7	73.9	40.6	.83	49.6	50.4	83.1	(2.84)	29.1	74.5	55.2	(3.59)	94.5
207	RL........	12.8	9.1	78.8	37.8	.83	49.6	52.9	88.3	(2.84)	26.1	80.2	52.5	(3.09)	76.0
208	RLP.......	10.8	14.4	84.5	41.7	.83	53.5	53.3	88.1	(3.20)	32.8	81.1	50.5	(3.44)	96.2
209	RLPK.....	11.3	18.2	88.7	44.5	.17	50.4	52.6	92.3	(3.11)	34.8	79.0	56.4	(3.15)	82.7
210	0..........	11.7	15.0	80.5	45.5	(1.24)	39.6	48.7	75.5	(4.59)	36.8	64.5	45.9	(2.74)	68.7

TABLE 5.—ALEDO FIELD, Concluded

Plot No.	Soil treatment applied	1910 Oats[5]	1911 Soybeans[1]	1912 Wheat[3]	1913 Corn	1914 Oats	1915 Soybeans	1916 Wheat	1917 Corn	1918 Oats	1919 Soybeans	1920 Wheat	1921 Corn	1922 Oats	1923 Spring wheat
301	0...........	64.1	15.7	11.5	45.8	42.2	(1.38)	10.2	40.5	74.8	(1.29)	34.8	65.3	65.0	19.4
302	M.........	58.6	17.1	12.6	44.2	51.6	(1.48)	22.2	55.5	76.9	(1.80)	41.5	71.2	68.3	25.0
303	ML........	64.7	15.9	11.7	51.0	52.3	(1.52)	15.8	64.4	83.3	(1.76)	39.7	77.2	72.2	22.6
304	MLP......	57.3	13.6	13.8	49.9	53.1	(1.59)	19.2	68.7	73.4	(1.93)	43.2	74.7	70.3	22.6
305	0...........	68.8	16.9	18.1	43.3	51.2	19.8	12.0	54.9	72.3	12.6	35.2	64.5	53.8	19.2
306	R..........	64.5	15.8	14.4	46.0	51.6	19.8	12.2	53.7	71.4	14.5	29.9	58.6	52.2	19.6
307	RL........	67.2	17.1	10.0	50.1	51.9	22.5	9.2	64.4	78.3	16.2	31.7	74.0	69.8	23.5
308	RLP.......	55.9	13.3	10.8	48.8	55.2	24.0	12.8	68.6	78.1	17.6	38.5	66.0	68.8	22.8
309	RLPK.....	66.7	13.2	13.3	50.5	52.5	24.8	16.2	70.1	72.3	18.1	38.2	67.0	64.8	22.0
310	0...........	53.6	15.0	9.0	44.8	45.8	(1.44)	13.7	55.6	66.6	(1.37)	37.8	59.7	53.4	17.0

Plot No.	Soil treatment applied	Corn[5]	Oats[1]	Soybeans[2]	Wheat[3]	Corn	Oats	Clover	Wheat	Corn	Oats	Clover Hay	Clover Seed	Wheat	Corn	Oats
401	0...........	45.9	53.3	(1.41)[6]	39.6	43.7	71.9	(3.26)	21.4	78.8	53.3	(1.84)		40.9	67.4	58.0
402	M.........	74.9	51.7	(1.41)[6]	37.7	57.6	82.0	(3.63)	23.3	85.8	54.2	(2.46)		48.4	84.3	58.4
403	ML........	81.2	53.4	(1.41)[6]	38.0	60.0	89.7	(3.90)	18.6	90.3	49.5	(2.48)		50.8	85.5	77.2
404	MLP......	82.1	51.6	(1.41)[6]	37.7	62.9	93.4	(3.86)	19.4	89.4	51.9	(2.68)		50.5	82.6	83.8
405	0...........	80.9	39.7	16.4	38.2	38.7	73.4	.25	28.2	81.8	49.7	(1.57)	2.75	41.7	71.7	56.3
406	R..........	67.7	60.3	15.2	42.3	47.9	74.5	.33	26.9	85.2	51.4	(1.58)	1.71	43.8	74.7	67.7
407	RL........	67.4	62.8	14.6	38.8	48.3	83.6	.25	28.0	97.1	52.3	(1.51)	.96	45.0	77.7	69.4
408	RLP.......	71.7	62.5	16.4	40.0	48.4	81.2	.25	28.2	96.7	50.9	(1.48)	1.50	50.6	79.0	74.1
409	RLPK.....	77.8	55.5	15.8	38.9	52.7	93.8	.18	22.7	98.3	53.0	(1.28)	1.17	42.2	78.5	74.5
410	0...........	67.1	52.3	14.5	34.7	40.7	58.3	(2.30)	20.8	72.8	47.3	(1.50)		40.7	62.5	74.1

[1]Residues only. [2]No manure, phosphate, or potassium. [3]No manure. [4]No manure or lime. [5]No treatment. [6]Estimated.

TABLE 6.—ALEDO FIELD: GENERAL SUMMARY OF THE GRAIN CROPS
Average Annual Yields 1912-1922—Bushels per acre

Serial Plot No.	Soil treatment applied	Wheat 8 crops	Corn 11 crops	Oats 10 crops
1	0	29.9	57.3	59.0
2	M	34.0	68.7	63.8
3	ML	33.4	70.8	65.0
4	MLP	35.5	72.2	64.7
5	0	31.2	59.4	61.2
6	R	31.5	63.2	60.4
7	RL	32.4	69.5	64.5
8	RLP	36.9	70.4	65.2
9	RLPK	35.0	70.8	67.2
10	0	31.1	58.7	56.0
	M over 0	3.3	10.2	5.1
	R over 0	.8	.9	2.5
	ML over M	−.6	2.1	1.2
	RL over R	.9	6.3	4.1
	MLP over ML	2.1	1.4	−.3
	RLP over RL	4.5	.9	−.7
	RLPK over RLP	−1.9	.4	2.0

average yields, the increase becoming particularly marked in the corn crop in the residues system.

Aside from the case of the wheat, the results show little or no effect from adding rock phosphate to the treatment, and at prevailing prices the cost of applying the phosphate would not be covered. However, the economic story has not all been told, for the application of lime and phosphate on these plots is to be discontinued in order to observe the residual effects. The results of the next few years, therefore, will be awaited with great interest.

For the effect of potassium treatment, we may compare Plots 8 and 9. No significant response appears as the result of applying potassium, so far as these common field crops show.

Future Experiments on the Major Series

A number of problems have arisen out of the experience on this and other experiment fields which call for some revision of the investigations described above, and accordingly certain changes are to be made in the future conduct of these plots to which attention may be called at this point.

It seems evident from the results presented above that limestone is not needed on this field to the extent to which it has been applied. Limestone, therefore, is to be temporarily discontinued on some plots until its need shall be made manifest by the behavior of sweet clover or thru other tests.

Another problem needing investigation is the economic use of rock phosphate. This material has been applied on these plots liberally, so that a considerable reserve of phosphorus should have accumulated. In order to observe the residual effect of rock phosphate, the application of this material will likewise be discontinued after bringing the total quantity applied up to 4 tons per acre. At the same time, a comparison of rock phosphate with acid phosphate and with bone meal will be made.

In order to provide for these new experiments, the plots of the major series will be divided in the middle into east and west halves. Aside from a change in the crop rotation affecting all plots in these series, the west half of each plot will receive essentially the same treatment and management as in in past, and the new experiments will be mainly on the east halves.

Inasmuch as it is the present purpose merely to mention these changes without going into a discussion of details, the following tabular statement will suffice to outline the plan of the future experiments on these plots.

TREATMENT TO BE APPLIED ON SERIES 100, 200, 300 AND 400: ALEDO FIELD

Plot	West Half	East Half
1	None	Legume, residues, limestone[1]
2	Manure	Manure, rock phosphate
3	Manure, limestone[2]	Manure, limestone[2], bone meal
4	Manure, limestone[2], rock phosphate[3]	Manure, limestone[2], rock phosphate
5	None	Legumes, residues, acid phosphate
6	Legumes, residues	Legumes, residues, rock phosphate
7	Legumes, residues, limestone[2]	Legumes, residues, limestone[2], acid phosphate
8	Legumes, residues, limestone[2], rock phosphate	Legumes, residues, limestone[2], rock phosphate
9	Legumes, residues, limestone[2], rock phosphate[3], potassium	Legumes, residues, limestone[2], rock phosphate[3], potassium, gypsum
10	None	Legumes, residues, limestone[1], rock phosphate

[1] Limestone to be applied as needed.
[2] Limestone applications discontinued until needed.
[3] Rock phosphate applications discontinued.

In 1923 a modification of the cropping system was put into effect, the rotation being changed to corn, corn, oats, and wheat. The plan includes also a catch crop of annual sweet clover seeded with the oats on all plots and biennial sweet clover grown as green manure in the wheat on both halves of Plots 6, 7, 8, and 9 and on the east half of Plots 1, 5, and 10.

Experiments on the Minor Series

The so-called minor system of plots (Series 500, 600, 700, 800) on the Aledo field is given over to a comparison of the effectiveness of different carriers of phosphorus. The plots for this work were laid out in 1916. This land had been previously in alfalfa since 1911. Excellent crops of alfalfa were harvested, in one of the years nearly 7 tons per acre being recorded as the season's yield.

The crops planted each year on these plots are alike on all series and they have been grown as indicated in Table 7. It is planned that hereafter the crop of any year will correspond to that growing on the 200 series of the major system.

In this experiment each series contains four plots. Plot 1 receives residues treatment only; Plot 2 receives residues and phosphorus in one of the forms under test; Plot 3 receives residues, limestone, and phosphorus; and Plot 4 is similar to Plot 3 with phosphorus omitted. On the 500 series, steamed bone meal (bP) is used as the carrier of phosphorus and is applied at the rate of 200 pounds per acre per year. On the 600 series, acid phosphate (aP) is applied at the yearly rate of 333⅓ pounds per acre. On the 700 series, rock phosphate (rP) serves as the source of phosphorus, applied at the rate of 666⅔ pounds per acre yearly. On the 800 series, basic slag phosphate (sP) is applied at the rate of 250 pounds per acre yearly.

TABLE 7.—ALEDO FIELD: PHOSPHATE EXPERIMENT
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied[1]	1916[2] Corn	1917[2] Oats	1918[2] Soybeans	1919 Wheat	1920 Corn	1921 Oats	1922 Clover hay	1923 Corn	1924 Corn
501	R	53.4	85.5	18.9	32.4	72.8	48.9	(2.88)	83.5	58.2
502	RbP	61.7	91.7	19.0	34.7	86.4	61.9	(3.25)	82.7	66.0
503	RLbP	61.5	90.6	23.2	35.6	87.3	53.3	(3.48)	82.5	66.8
504	RL	55.1	80.5	22.6	32.9	77.7	47.7	(2.61)	88.2	60.3
601	R	55.2	84.7	19.5	33.0	71.2	53.6	(3.17)	84.7	57.3
602	RaP	57.8	87.7	18.7	38.3	87.1	60.9	(3.23)	82.5	65.9
603	RLaP	64.7	83.4	23.1	38.2	88.1	52.3	(3.53)	77.6	64.7
604	RL	51.9	81.7	24.6	32.8	84.9	50.2	(3.06)	84.1	51.9
701	R	54.3	83.1	20.8	34.2	75.6	52.8	(3.41)	82.8	61.2
702	RrP	58.8	83.3	23.3	36.7	80.4	63.0	(3.60)	87.8	69.3
703	RLrP	57.2	81.2	28.1	36.7	80.2	53.3	(3.82)	86.6	70.8
704	RL	52.1	81.7	26.9	34.1	82.0	48.9	(3.15)	84.6	62.5
801	R	57.6	73.8	18.0	33.7	68.1	54.8	(2.62)	74.3	58.8
802	RsP	56.4	87.8	20.6	38.1	81.0	66.2	(3.66)	80.0	69.1
803	RLsP	53.3	78.9	23.7	38.4	83.6	57.0	(3.63)	82.0	70.2
804	RL	51.8	77.5	21.8	33.3	70.4	59.8	(2.99)	82.6	59.9

[1]Bone meal (bP) at the rate of 200 pounds per acre per year.
Acid phosphate (aP) at the rate of 333⅓ pounds per acre per year.
Rock Phosphate (rP) at the rate of 666⅔ pounds per acre per year.
Slag phosphate (sP) at the rate of 250 pounds per acre per year.
All minerals applied once in the rotation ahead of the wheat crop.
[2]No residues.

The yields for all crops harvested on these plots during the first nine years are recorded in Table 7. Table 8, which is derived from Table 7, shows differences in crop yields presumed to have resulted from applying the various forms of phosphatic fertilizers for the nine crops harvested since the beginning of the applications up to 1924. In computing these comparisons all residues plots are combined into a single average for the respective crops, as are all lime-residues plots, and these figures stand as checks against those for the corresponding phosphated plots.

Aside from the soybeans, the figures show without exception more or less crop increase on the phosphorus plots, no matter what the form of carrier em-

TABLE 8.—ALEDO FIELD: CROP INCREASES FOR VARIOUS FORMS OF PHOSPHATE BASED UPON RESULTS IN TABLE 7
1916-1924

Comparison of treatments	Wheat *1 crop*	Corn *4 crops*	Oats *2 crops*	Clover *1 crop*	Soybeans *1 crop*
Bone meal and residues over residues	1.4	7.4	9.7	(.23)	−.3
Bone meal, lime, and residues over lime and residues	2.3	5.8	5.9	(.53)	−.8
Acid phosphate and residues over residues	5.0	6.5	7.2	(.21)	−.6
Acid phosphate, lime and residues over lime and residues	4.9	5.0	1.8	(.58)	−.9
Rock phosphate and residues over residues	3.4	7.3	6.0	(.58)	4.0
Rock phosphate, lime and residues over lime and residues	3.4	4.9	1.2	(.87)	4.1
Slag phosphate and residues over residues	4.8	4.8	9.9	(.64)	1.3
Slag phosphate, lime, and residues over lime and residues	5.1	3.5	1.4	(.68)	−.3

ployed. The difficulty, however, of arriving at a general conclusion regarding the comparative economy in the use of these different phosphorus materials is obvious, for all depends upon their relative cost, which fluctuates from time to time. Furthermore, the prices received from farm produce likewise fluctuate; and to complicate matters still further, these fluctuations do not necessarily run parallel with those of the fertilizer cost. However, one may readily compute for himself the relative economy of producing these crop increases by applying any set of prices for crops and fertilizers which appear to be most applicable according to prevailing market conditions.

For the purpose of furnishing an illustration of such a computation, the following set of arbitrary prices may be assumed as representing approximately average market conditions for the past ten years: wheat, $1.25 per bushel; corn, 75 cents; oats, 45 cents; soybeans, $1.50; and clover, $15 per ton. For the cost of the various phosphatic materials the following estimates are used: bone meal, $40 per ton; acid phosphate, $24; rock phosphate, $12; and slag phosphate, $20. These values seem to be conservative enough. The figures for crop values are all under the average December 1 farm price quotations for the ten-year period 1914-1923. Furthermore, it may be pointed out that the quantities of phosphatic materials employed in these experiments are, with the possible exception of the slag phosphate, greater than ordinarily would be used, or need to be used, in good farm practice.

Figured on the basis of these prices, it appears that both bone meal and acid phosphate, as used on these plots, have been applied at a financial loss, whether accompanied by limestone or not, while rock phosphate and slag phosphate have each yielded a profit. Counting in all crops, the net loss for bone meal was 4 cents per acre per year when applied without limestone, and 41 cents applied with limestone. The use of acid phosphate without limestone resulted in a loss of 17 cents, while with limestone the loss was 66 cents. Rock phosphate produced a profit of $1.14 when used without limestone, but with limestone the profit was reduced to 36 cents. Slag phosphate furnished the most profitable return of any of the phosphorus carriers, producing an average profit of $2.04 an acre yearly when used without limestone and 60 cents used with limestone.

In considering these figures let it be emphasized again that the order of these values might easily be shifted by a relatively small change in commodity prices.

Considering the results from the standpoint of limestone as applied on the plots of the minor series, the following observations are to be made.

Limestone at the rate of 4 tons per acre was applied to Plots 3 and 4 in 1912, when the land was still under alfalfa, and another dressing was added in 1917, after the present experiments were under way. The effect of this limestone, in terms of crop increase, is set forth in Table 9.

Comparing, first, the results from the check plots, which receive no phosphorus, it appears that the limestone used with residues alone has been of benefit to the corn and the soybean crops only.

Considering all treatments as a whole, the soybeans exhibit a consistent gain in yield from the use of limestone, while oats, on the other hand, respond by a consistent loss. Wheat and corn on the whole show a rather indifferent response. If we consider the money value of these crop increases on the same basis as above,

TABLE 9.—ALEDO FIELD: CROP INCREASES FOR LIMESTONE BASED UPON RESULTS IN TABLE 7
1916-1924

Comparison of treatments	Wheat *1 crop*	Corn *4 crops*	Oats *2 crops*	Clover *1 crop*	Soybeans *1 crop*
Residues, limestone over residues	.0	2.0	−1.2	(−.07)	4.7
Residues, limestone, bone meal over residues, bone meal	.9	.3	−4.8	(.23)	4.2
Residues, limestone, acid phosphate over residues, acid phosphate	−.1	.5	−6.4	(.30)	4.4
Residues, limestone, rock phosphate over residues, rock phosphate	.0	−.4	−5.9	(.22)	4.8
Residues, limestone, slag phosphate over residues, slag phosphate	.3	.7	−9.0	(.33)	3.1

we find a gross return for limestone, applied without phosphate, of $1.30 per acre per year. Limestone with bone meal has returned, in gross, 83 cents per acre per year; with acid phosphate, 73 cents; with rock phosphate, 44 cents; and with slag phosphate, 65 cents. It is doubtful, therefore, whether limestone, used with phosphates in the manner described has, up to the present time, paid its cost on these plots. The Aledo field represents one of these borderline cases, so to speak, in which the upper soil is neutral or only slightly acid and the lime requirement, therefore, not yet very marked. As time goes on, however, and cropping continues, the need of lime will develop. It is planned to discontinue liming on these plots until its need becomes manifest, and in so doing the annual cost of the limestone already applied will become automatically reduced, so that net returns which hitherto have represented a loss may sooner or later result in a positive profit.

The Galesburg Field

Another field which should be of especial interest in this Report, because it was located only a few miles from Mercer county, is the Galesburg field on Brown Silt Loam. This field lay six miles west of Galesburg. It was established in 1904 and was continued until 1918. It was laid out into three series of twenty plots each with treatments as indicated in Table 10. The original rotation was corn, corn, oats, wheat, clover, and timothy, but this was changed in 1909 to corn, corn, oats, clover, wheat, and clover.

All phosphorus was applied in the form of rock phosphate at the rate of 500 pounds per acre per year. At the beginning, a dressing of 1,300 pounds of limestone per acre was applied and no more was applied until 1913, when an application of 4 tons per acre was made. The potassium was applied in 100 pounds of potassium sulfate per acre. On Plot 19 nitrogen was applied in 200 pounds of dried blood per acre yearly. Some legume cover crops were grown in the corn.

A general summary of the annual crop yields is assembled in Table 10. For the sake of convenience in studying the effect of the treatments, the various possible comparisons are brought together in Table 11, where the results are ex-

pressed in terms of crop increases. Following are some of the salient points brought out by these comparisons.

1. Residues without limestone produced very little effect on crop yields, but used with limestone there was a noticeable increase in the residues plots over the non-residues plots.

2. Manure used in the liberal manner of these experiments, along with limestone, produced very beneficial effects. Measured by crop increases, the effect of manure and limestone was about twice that of residues and limestone. It should be borne in mind, however, in this connection that in this system the land received regularly about 3 tons of manure per acre yearly, a practice that would be difficult to carry out on many farms.

3. The use of limestone alone, all crops considered, resulted in a financial loss. In combination with residues, however, limestone produced a beneficial effect.

4. Rock phosphate in the residues system produced very pronounced and profitable increases in crop yields, used either with or without limestone. Also, without residues the increases in crop yields were large.

Used with animal manure, however, the increases resulting from phosphate were not nearly so large; in fact, the increases attributable to phosphorus in the manure system are scarcely sufficient to cover the cost of the rock phosphate employed. This is a commonly observed result, explained probably by the fact that

TABLE 10.—GALESBURG FIELD: GENERAL SUMMARY OF CROP YIELDS

Average Annual Yields 1908-1918—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn following clover *6 crops*	Corn following corn *5 crops*	Corn average *11 crops*	Oats *5 crops*	Wheat *4 crops*	Barley *1 crop*	Clover *4 crops*	Soybeans *4 crops*
1	L.........	54.8	45.9	50.8	44.4	21.7	22.5	(2.12)	(1.16)
2	RL........	65.6	53.1	59.9	47.5	26.6	27.1	....	13.8
3	ML.......	73.8	61.1	68.0	47.8	28.9	25.5	(2.67)	(1.56)
4	CvML.....	75.1	60.8	68.6	47.4	28.4	25.6	(2.45)	(1.53)
5	L.........	61.6	51.0	56.7	46.8	25.2	21.7	(2.37)	(1.27)
6	LP........	70.6	58.1	64.9	51.1	33.8	24.2	(2.86)	14.1
7	RLP......	74.9	58.0	67.2	51.8	36.4	29.8	....	15.6
8	MLP......	76.1	65.1	71.1	51.0	32.7	26.8	(2.90)	(1.65)
9	CvMLP ...	74.7	66.1	70.8	50.8	33.3	33.0	(2.91)	(1.62)
10	L.........	59.7	47.3	54.1	45.9	22.2	23.0	(1.94)[1]	12.7
11	LPK......	68.8	60.9	65.2	49.4	32.7	22.7	(3.03)	15.5
12	RLPK.....	75.1	61.7	69.0	48.2	34.8	38.4	....	15.9
13	MLPK....	73.8	63.8	69.3	49.8	32.3	29.7	(3.11)	(1.75)
14	CvMLPK..	74.8	67.0	71.3	48.0	33.3	35.1	(3.27)	(1.67)
15	L.........	60.7	46.1	54.0	43.4	19.6	25.5	(2.08)	(1.31)
16	R.........	62.8	49.7	56.8	43.7	24.7	33.3	....	12.5
17	RP........	71.1	54.2	63.4	51.9	36.0	31.5	....	14.2
18	RPK......	74.3	56.4	66.2	51.9	39.2	32.6	....	14.3
19	RLNPK...	79.1	60.4	70.6	52.4	36.5	39.1	....	17.4
20	0..........	59.3	47.6	54.0	43.3	25.8	24.9	(1.82)	(1.14)

[1]Only 2 crops from this plot.

the manure itself carries a considerable quantity of phosphorus which supplies directly much of the crops' need for this element of plant food.

5. Potassium in the form of potassium sulfate appears in five different fertilizer combinations on these plots, but the various possible comparisons show no significant effect from potassium. In a large proportion of the cases the figures indicating increase carry the minus sign, and altogether the small differences exhibited are doubtless well within experimental error.

6. Nitrogen, as applied in the form of dried blood and in combination with residues, limestone, phosphorus, and potassium, likewise proved ineffective, resulting in a considerable economic loss thru cost of material.

7. Cover crops, in the three different combinations tried, produced no significant effect so far as crop yields indicate.

TABLE 11.—GALESBURG FIELD: EFFECT OF TREATMENTS IN TERMS OF ANNUAL CROP INCREASES

Bushels or (tons) per acre

Comparison of treatments	Corn *11 crops*	Oats *5 crops*	Wheat *4 crops*	Barley *1 crop*	Clover *4 crops*	Soybeans *4 crops*
Residues						
R over 0	2.8	.4	−1.1	8.4	....	....
RL " L	6.0	2.4	4.4	3.9	....	1.1
RLP " LP	2.3	.7	2.6	5.6	....	1.5
RLPK " LPK	3.8	−1.2	2.1	15.7	....	.4
Manure						
ML over L	14.1	2.7	6.7	2.3	(.54)	(.31)
MLP " LP	6.7	− .1	6.1	2.6	(.04)	....
MLPK " LPK	4.1	.4	− .4	7.0	(.08)	....
Limestone						
L over 0	− .1	1.8	−2.6	−1.7	(.31)	(.11)
LR " R	3.1	3.8	1.9	−6.2	....	1.3
LRP " RP	3.8	− .1	.4	−1.7	....	1.4
LRPK " RPK	2.8	−2.7	−4.4	5.8	....	1.6
Phosphorus						
PR over R	6.6	8.2	11.3	−1.8	....	1.7
PL " L	11.0	6.0	11.6	1.0	(.73)	1.4
PRL " RL	7.3	4.3	9.8	2.7	....	1.8
PML " ML	3.1	3.2	3.8	1.3	(.23)	(.09)
PMLCv " MLCv	2.2	3.4	4.9	7.2	(.46)	(.09)
Potassium						
KRP over RP	2.8	0.0	3.2	1.1	....	.1
KLP " LP	.3	−1.7	−1.1	−1.5	(.17)	1.4
KRLP " RLP	1.8	−3.6	−1.6	8.6	....	.3
KMLP " MLP	−1.8	−1.2	− .4	2.9	(.21)	(.10)
KMLPCv " MLPCv	.5	−2.8	0.0	2.1	(.36)	(.05)
Commercial nitrogen						
NRLPK over RLPK	1.6	4.2	1.7	.7	....	1.5
Cover Crops						
CvML over ML	.6	− .4	− .5	.1	(−.22)	(−.03)
CvMLP " MLP	− .3	− .2	.6	6.2	(−.01)	(−.03)
CvMLPK " MLPK	2.0	−1.8	1.0	5.4	(.16)	(−.08)

TABLE 12.—KEWANEE FIELD: GENERAL SUMMARY OF THE GRAIN CROPS
Average Annual Yields 1917-1924—Bushels per acre

Serial Plot No.	Soil treatment applied	Wheat *6 crops*	Corn *8 crops*	Oats *8 crops*
1	0	31.0	54.1	58.8
2	M	32.7	63.5	68.1
3	ML	35.6	67.6	71.3
4	MLP	38.8	67.6	70.1
5	0	32.2	55.1	60.9
6	R	32.9	56.9	58.7
7	RL	33.1	65.7	63.0
8	RLP	38.1	68.8	65.9
9	RLPK	38.2	71.7	67.5
10	0	30.6	50.6	55.3
	M over 0	1.4	10.2	9.8
	R " 0	1.6	3.6	.4
	ML " M	2.9	4.1	3.2
	RL " R	.2	8.8	4.3
	MLP " ML	3.2	0.0	−1.2
	RLP " RL	5.1	3.1	2.9
	RLPK " RLP	.1	2.9	1.6

The Kewanee Field

Another field in the vicinity of Mercer county representing Brown Silt Loam is the Kewanee field, located in Henry county about three miles southwest of Kewanee. This field has been under way since 1915. The crops grown are wheat, corn, oats, and clover. The arrangement of plots and the treatments applied are indicated in Table 12. This table includes the yields of the grain crops only.

Summarizing the data as in Table 12 the following observations may be made.

1. The response to treatment with stable manure stands out clearly in the increased production.

2. Residues without limestone have not produced a very decided effect on crop yields.

3. The effect of limestone appears to have been beneficial used either with manure or with residues.

4. Phosphorus, as usual, has been more effective applied with residues than with manure. In the residues system the rock phosphate has been applied with profit, while in the manure system the increases in crop yield are not sufficient to cover the cost.

5. Potassium has produced no effect upon the yields of these crops that can be considered significant.

EXPERIMENTS ON BLACK CLAY LOAM

The Hartsburg Field

The results of experiments on the Hartsburg field are introduced as representing the soil type Black Clay Loam. This field is located in Logan county just east of Hartsburg. The work began in 1913. The field was laid off into

TABLE 13.—HARTSBURG FIELD: GENERAL SUMMARY OF THE GRAIN CROPS
Average Annual Yields 1913-1924—Bushels per acre

Serial Plot No.	Soil treatment applied	Wheat *9 crops*	Corn *12 crops*	Oats *11 crops*
1	0	23.9	44.0	46.6
2	M	29.3	52.6	51.8
3	ML	36.1	59.5	57.8
4	MLP	39.0	58.5	57.7
5	0	31.8	48.3	44.7
6	R	34.3	59.3	54.6
7	RL	32.8	64.0	52.5
8	RLP	36.5	61.9	56.8
9	RLPK	35.4	61.7	56.2
10	0	32.3	49.0	47.9
	M over 0	0.0	5.5	4.4
	R " 0	5.0	12.2	7.2
	ML " M	6.8	6.9	6.0
	RL " R	−1.5	−2.1	4.7
	MLP " ML	2.9	−1.0	− .1
	RLP " RL	3.7	−2.1	4.3
	RLPK " RLP	− .9	− .2	− .6

five series of 10 plots each. The crop rotation up to 1923 was wheat, corn, oats, and clover, with alfalfa growing on a fifth series. The soil treatments are as indicated in Table 13. The table summarizes the yields, by crops, for the period during which the plots have been under full treatment.

The outstanding feature of these results is the large increase in yields produced by residues, which even exceeds the increase brought about by the use of stable manure.

The behavior of limestone on this field is rather peculiar in that it has been more beneficial where applied with manure than where used with residues. Used with manure, limestone gave a substantial increase in all grain crops, while with residues, the effect on both wheat and corn appears negative.

Altho rock phosphate has given some increases in wheat yield in both manure and residues systems, the results with other crops have been such as to render the use of this material unprofitable on this field.

The addition of potassium appears to have produced a slightly depressing effect upon the yields of all grain crops.

It may be mentioned that new experiments have been recently started on these plots which are designed to answer some of the questions brought out by the foregoing results. For example, the effect of applying phosphorus in other carriers and in different combinations, as well as testing the residual effect of phosphate already applied, will be tried.

EXPERIMENTS ON YELLOW SILT LOAM

Inasmuch as about one-fifth of the area of Mercer county is made up of Yellow Silt Loam, much of which is subject to erosion, it is believed that an account of some experiments on the Vienna field will be of interest here.

The Vienna Field

In 1906 the University acquired a sixteen-acre tract of land near Vienna in Johnson county. The whole area with the exception of about three acres had been abandoned because so much of the surface soil had washed away and there were so many gullies as to render further cultivation of this land unprofitable. Experiments were started at once to reclaim this land, the different methods described below being used for this purpose.

The field was divided into five sections. The sections designated as A, B, and C were divided into four plots each, and D into three plots. On section A, which included the steepest part of the area and contained many gullies, the land was built up into terraces at vertical intervals of five feet. Near the edge of each terrace a small ditch was placed so that the water could be carried to a natural outlet without doing much washing.

On section B the so-called embankment method was used. By this method erosion is prevented by plowing up ridges so that water will run over in a broad sheet rather than in narrow channels. At the steepest part of the slope, hillside ditches were made for carrying away the run-off.

Section C was washed badly but contained only small gullies. Here the attempt was made to prevent washing by incorporating organic matter in the soil and practicing deep contour plowing and contour planting. With two exceptions, about eight loads of manure per acre were turned under each year for the corn crop.

The land on section D was washed to about the same extent as that of section C. As a check on the different methods of reducing erosion, the land on section D was farmed in the most convenient way, without any special effort being made to prevent washing.

Section E was badly eroded and gullied and no attempt was made to crop it other than to fill in the gullies with brush and to seed the land to grass.

Sections A, B, C, and D were not entirely uniform; some parts were washed more than others and portions of the lower-lying land had been affected by soil material washed down from above. When the field was secured, the higher land had a very low producing capacity. On many spots little or nothing would grow.

Limestone was applied to the entire field at the rate of 2 tons per acre. Corn, cowpeas, wheat, and clover were grown in a four-year rotation on each section except D which had but three plots.

Table 14 contains a summarized statement of the results obtained.

TABLE 14.—VIENNA FIELD: HANDLING HILLSIDE LAND TO PREVENT EROSION
Average Annual Yields, 1907-1915—Bushels or (tons) per acre

Section	Method	Corn *7 crops*	Wheat *7 crops*	Clover *3 crops*
A	Terrace	31.4	9.0	(0.68)
B	Embankments and hillside ditches	32.4	12.7	(0.97)
C	Organic matter, deep contour plowing, and contour planting	27.9	11.7	(0.80)
D	Check	14.1	4.6	(0.21)

FIG. 4.—VIEW OF AN UNIMPROVED HILLSIDE JUST OVER THE FENCE FROM THE FIELD SHOWN IN FIG. 5

These results indicate something of the possibilities in improving hillside land by protecting it from erosion. The average yield of corn from the protected series (A, B, and C) was 30.6 bushels per acre, as against 14.1 bushels for series D; wheat yielded 11.1 bushels in comparison with 4.6 bushels; and clover .82 ton in comparison with .21 ton.

A comparison of Figs. 5 and 6 will serve to indicate the possibility of improving this type of soil.

EXPERIMENTS ON DUNE SAND

In 1913 the University came into possession of a tract of Dune Sand, Terrace, in Henderson county, near the Mississippi river, upon which an experi-

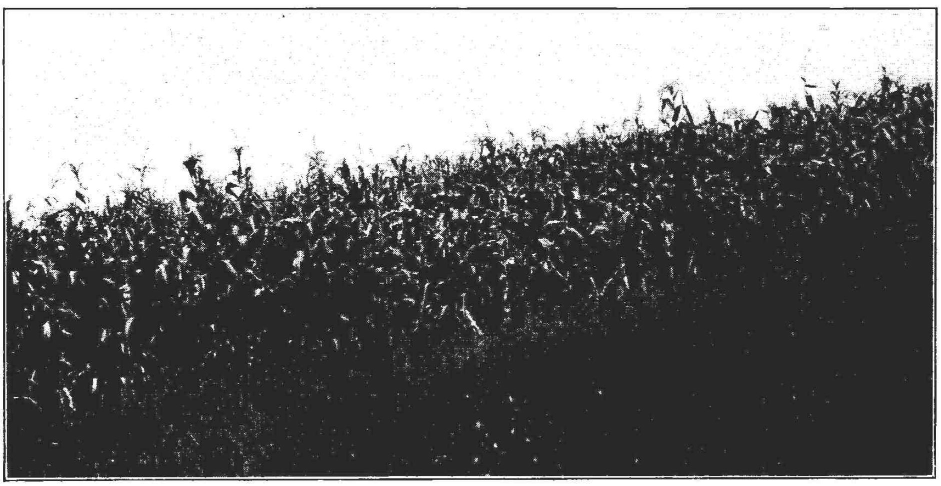


FIG. 5.—CORN GROWING ON IMPROVED HILLSIDE OF THE VIENNA EXPERIMENT FIELD. THIS LAND FORMERLY HAD BEEN BADLY ERODED. COMPARE WITH FIG. 4

ment field was laid out to determine the needs of these sand soils. This field is divided into six series of plots. Corn, soybeans, wheat, sweet clover, and rye, with a catch crop of sweet clover seeded in the rye on the residues plots, are grown in rotation on five series, while the sixth series is devoted to alfalfa. When sweet clover seeded in the wheat fails, cowpeas are substituted.

No catch of alfalfa or of sweet clover was obtained till the alfalfa drill was used in seeding. With this implement the seed is covered about one-half inch deep.

Table 15 indicates the kinds of treatment applied, the amounts of the materials used being in accord with the standard practice, as explained on page 41.

The data make apparent the remarkably beneficial action of limestone on this sand soil. Where limestone has been used in conjunction with crop residues, the yield of corn has been doubled. The limestone has also produced good crops of rye and fair crops of sweet clover and alfalfa.

This land appears to be quite indifferent to treatment with rock phosphate. The analyses show, however, that the stock of phosphorus in this type of soil is not large, and it may develop as time goes on and the supply diminishes along with the production of good-sized crops, that the application of this element will become profitable. It is also quite possible that a more available form of phosphate could be used to advantage on this very sandy soil.

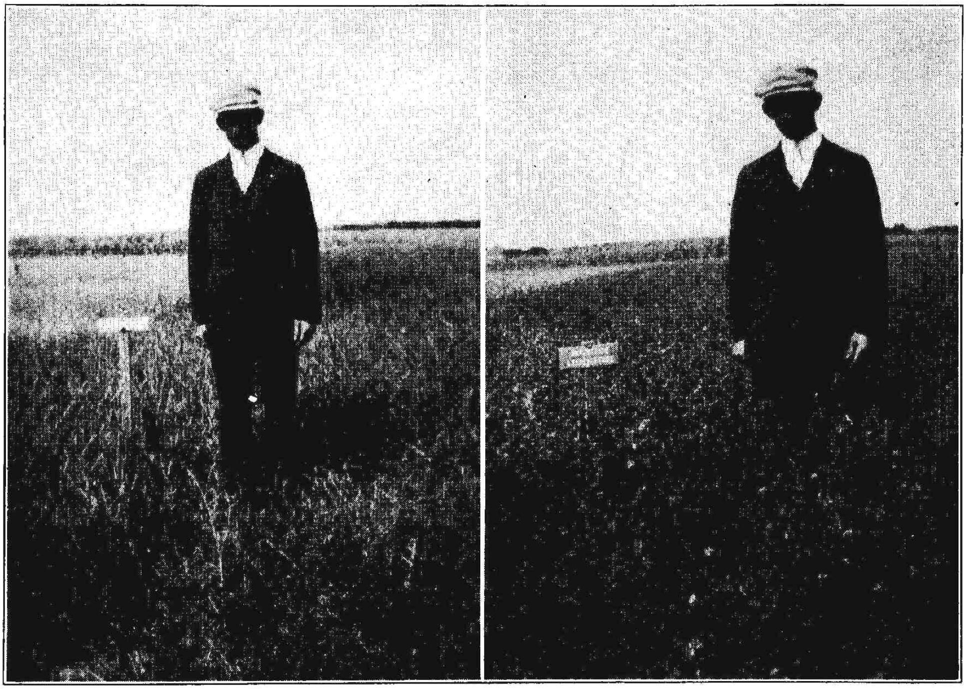
Altho the results show an increase of 3.5 bushels of corn from the use of potassium salts, with ordinary prices this would not be a profitable treatment. The slight increase from the use of potassium appearing in the other crops can scarcely be considered significant.

A significant fact which the general summary does not bring out is that the improvement under favorable treatment has been progressive, as evidenced by a very marked upward trend in production after the first few years. For example, we note that the yield of corn under the limestone-residues treatment has

TABLE 15.—OQUAWKA FIELD: GENERAL SUMMARY OF CROP YIELDS
Average Annual Yields 1915-1923—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn *9 crops*	Soybeans *8 crops*		Wheat *9 crops*	Sweet clover[1] *7 crops*		Rye *7 crops*	Alfalfa *6 crops*
			Hay *5 crops*	Seed *3 crops*		Hay *4 crops*	Seed *3 crops*		
1	0..........	17.8	(.89)	8.1	7.3	(.00)	.00	11.7	(.32)
2	M.........	22.1	(1.01)	9.7	10.0	(.00)	.00	12.8	(.52)
3	ML........	27.8	(1.27)	12.8	13.4	(1.20)	1.06	22.7	(1.98)
4	MLP......	26.2	(1.20)	13.0	13.7	(1.26)	.99	21.6	(2.12)
				Seed *8 crops*		Hay *2 crops*	Seed *5 crops*		
5	0..........	17.4	....	5.6	9.5	(.00)	.00	11.8	(.07)
6	R.........	20.4	....	5.7	10.3	(.00)	.00	12.9	(.06)
7	RL........	34.6	....	8.8	13.0	(1.47)	1.61	23.9	(1.79)
8	RLP......	34.0	....	8.9	13.6	(1.39)	1.45	24.5	(1.71)
9	RLPK.....	37.5	....	8.3	12.4	(1.53)	1.72	25.3	(1.86)
10	0..........	17.0	(.60)	6.1	7.9	(.00)	.00	11.0	(.03)

[1]In 1918 sweet clover was killed by being cut for hay. Soybeans were seeded on these plots and the following yields obtained: .86, 1.10, 1.93, and 2.00 tons of hay per acre on Plots 1 to 4; 11.1, 9.9, 14.6, 15.8, and 16.6 bushels of seed per acre on Plots 5 to 9; and .62 ton of hay per acre on Plot 10.



Manure
Yield: Nothing

Manure and limestone
Yield: 4.43 tons per acre

FIG. 6.—ALFALFA ON OQUAWKA FIELD IN 1918

been 34.6 bushels per acre as an average for the 9 crops since full treatment started, but if we take an average of the last five crops the yield rises to 42.7 bushels. Likewise the wheat under this same treatment gives for the 9-year average 13 bushels, but the last five years has given 16.9 bushels.

Experience thus far shows rye to be better adapted to this land than wheat, and both alfalfa and sweet clover thrive better than soybeans. With these two legume crops thriving so well under this simple treatment, we have promise of great possibilities for the profitable culture of this land, which hitherto has been considered as practically worthless.

Soil Reports Published

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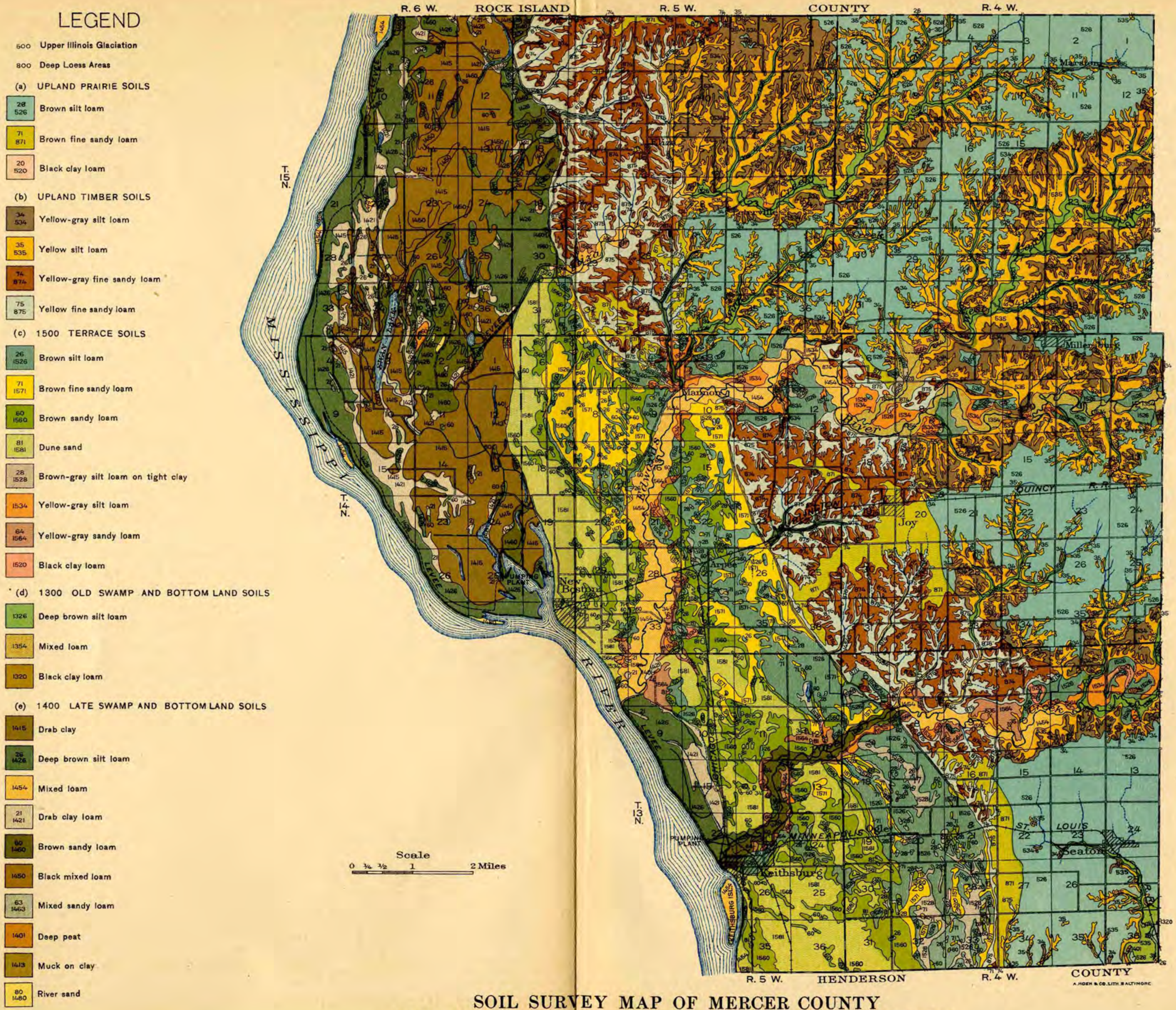

SOIL SURVEY MAP OF MERCER COUNTY
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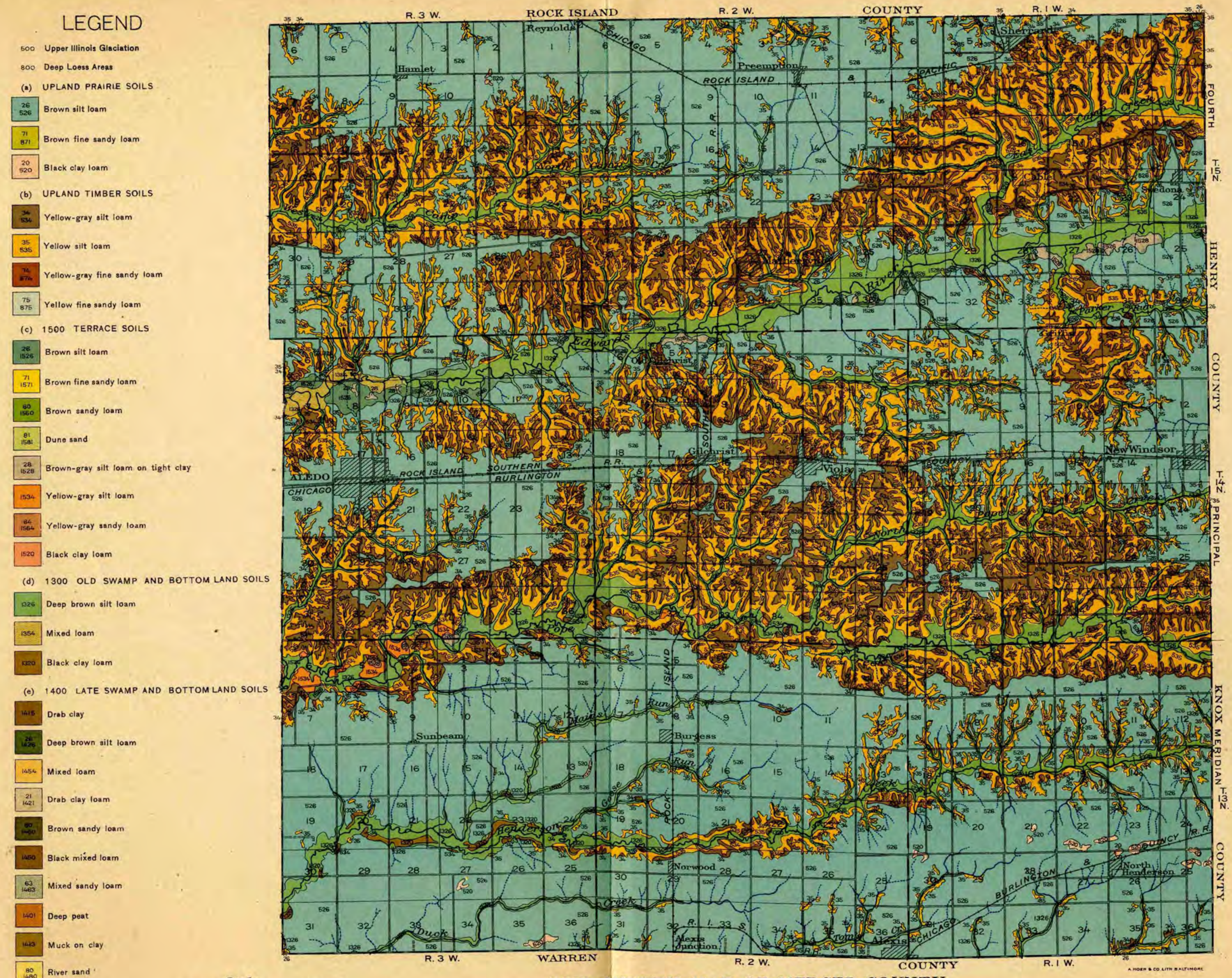

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